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THE LONGITUDE *Demonſtrated,*

By the Uſe of a *Silent Pendulum*; that keeps true Time at Sea. And made plain (by an *Index* Inſtrument) to the meaneſt Capacity.

With a New *Obſervatory* for finding the *Meridian Altitude* of Sun or Stars, and a great Improvement of the *Sun-Quadrant*; which are more exact than any heretofore known: With fair Copper Cuts of the *Machine*, and all the other Inſtruments.

And a Table of the Acceleration of fixed Stars, more exact than any heretofore extant; with the Sun's *Declination*, *Right Aſcenſion*, and *Equation* of Time; and other uſeful Tables fitted to this Work.

An Experiment of what Proportion a Pendulum lengthens in the greateſt Heat, where Animals can live, or Vegetables grow; and at ſeveral other Degrees of Heat, to red-hot.

With a Method to make a Pendulum to fit all Climates; with ſeveral other uncommon Experiments.

K

By *JONAH CRATHORNE.*

London, Printed for *W. Graves*, at the *Black-ſpread-Eagle* in *Pater-noſter-row*; and ſold by *J. Graves*, at the *Bible* in St. *James's-ſtreet*, and *J. Holland*, at the *Bible* and *Globe* in St. *Paul*'s Church-yard, 1718.

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GR III
BR. MUS.

To the Great Prince, *GEORGE*, KING of *Great-Britain*, &c.

May it pleaſe the King,

AS it has been a Cuſtom both Antient and Modern, to dedicate New Diſcoveries, and profitable Inventions to their Kings and Princes; that by their Royal Patronage thoſe Diſcoveries might the better circulate through their Dominions: I Hope this Boldneſs may be pardoned for prefixing ſo great a Name to this ſmall Treatiſe, ſeeing the Invention of the Subject Matter thereof, repreſented by the following Diagram, was found out immediately after thy Royal Perſon aſcended the Throne (altho' it had been many Years ſtudied for; not only by the Author but by many others, and in divers Nations.) And while this Treatiſe was in the Preſs, was pleaſed for the Encouragement of the Trade of the Subjects, to honour a conſiderable Company of Merchants with being their Governour; Which ſhews a Proſpect of a flouriſhing Trade under ſo powerful a Prince, that delights ſo much in Naval Commerce; and that is ſo ready to promote every Thing that may make ſo flouriſhing a Trade amongſt his People: That Art may neither periſh, nor ſeek its Encouragement in Foreign Kingdoms; but be nouriſhed in its Native Land. So the Author craves this may find ſome favourable Acceptance with the King; and by that Encouragement may not only be of a publick Benefit to theſe Kingdoms, but of all *Europe*; making no Apologie for the Inſtruments, not doubting but upon Tryal, they will anſwer much nearer than any heretofore extant. So remains the Kings faithful and obedient Subject

Jonah Crathorne.

THE

The PREFACE.

I *Shall here acquaint thee with the Reaſons that induc'd me to the Study of making a Machine to keep true Time at Sea. I being in Company with one* John Etherington, *of* Drifeild *in* Yorkſhire; *who acquainted me that he had been Mate of an* Eaſt-India *Ship, and being homeward bound, richly laden; by falling into a Current, they brought the Log home, that is, they over-run their Reckoning* 80 *Leagues, and loſt their Ship upon a Sand, which they ſuppoſed was* 80 *Leagues off. This great Miſtake put me upon Thoughts, that if they had had but a good Time-piece on board, that would have kept Time to a Minute in a Month, it would have corrected that great Error: Or if it had come within* 4 *Minutes a Month; it might have been a means of ſaving the Ship and Men from that Diſtreſs they were driven to; which he related to me. And I being often in Company with ingenious Mathematicians, and experienced Mariners; who did unanimouſly agree, that nothing was more wanting towards the Perfection of Navigation than the Diſcovery of the Longitude; which they concluded, no Inſtrument yet invented could contribute ſo much thereto, as a true going* Pendulum *if it could be made to go at Sea, as well as at Land, upon which I had Thoughts ſeveral Years ago; and at laſt I fell upon applying a* Silent Pendulum, *which would give true and equal Vibrations; altho' the Machine with the Frame it ſtood upon declined either Way* 30 *or* 40 *Degrees from the Perpendicular, and equal again in the Perpendicular. This gave Thoughts to ſome ingenious Men, to whom I ſhewed this Secret, that it might be made a ſerviceable Inſtrument towards the*

Diſcovery of the Longitude, ſeeing they believed it would go at Sea as well as at Land; then I came to contrive proper Frames to fix it in a Ship, that altho' it would go true ſo far from the Perpendicular, yet the nearer it kept to the Perpendicular the better as I thought; ſo that I found proper Frames to place it in, that it cannot be One Tenth of a Degree from the Perpendicular at the declining of the Ship 30 or 40 Degrees any ways: And I have had it going near 3 Years, and in this time it hath been viſited by many eminent Mathematicians, and experienced Mariners, with Approbation; that it would be a uſeful Instrument for the Purpoſe intended: Seeing they all agreed that the Longitude could not be diſcovered without a true Time-keeper, which they believed it might perform when they ſee the Advantages it had for that Purpoſe, and the true Motion it had in any Declination that the Ship could have: So that in due Time it might bring Clocks to be as uſeful in Ships as in Houſes, and to have more Occaſion for them, ād receive much more Advantage from them, which ^ may be an Advancement to the Trade and Commerce of the Nation, by ſaving the Ships and Mens Lives.

So kind Reader, I hope thou wilt excuſe the Meanneſs of the Stile, as being purely Mechanick. And as the applying of a Silent Pendulum, and other Methods here mentioned, I think I may preſume to ſay, no Man hath done it before me: So I hope it will not be amiſs to inform the World of ſomething that may be advantageous to humane Life, that was not known in former Times.

Farewel,

Jonah Crathorne.

MANY have endeavoured to find the Difference of Meridians at Sea, but none that I know of have come any thing near the Matter.

Except the Author of this Book who hath ſhewn me his whole Contrivance, which is indeed very neat; and I am of Opinion that his *Silent Pendulum* and *Obſervatory* (as he calls them) will be of great Uſe at Sea, becauſe they cannot be injured by the moſt violent Motion of a Ship.

Therefore I hope the Author will meet with due Encouragement, from ſuch honourable Perſons, as are concerned in this Affair.

John Newton.

Warwick-lane, De-
cemb. *the* 2*d*, 1717.

Note 1. THE Silent Pendulum is applicable to the Short Pendulum as well as the Long, and the multiplying of Balls and Sockets; with proper Frames to place a Clock in, was invented by the Author.

2. That a Pendulum to fit all Climates, mentioned Page 40, may be made with a Screw at the Top, inſtead of that at the low End of the Rod; with the ſame Thread of Screw about 55 in an Inch, and a ſquare Piece below the Screw to faſten the Spring to, having a ſquare Hole to draw through above the Cock, and upon it a Circle placed horizontal, divided into 90 equal Parts; the Screw going through the middle of an Index will gradually lengthen and ſhorten near as well as the other; and then have the Pendulum Ball flat, as is common; but make the Rod oval moving edge ways.

3. Where the true time is expreſſed, its meaning is the equal or mean Time, diſtinguiſhed from the apparent Time, allows every Day 24 equal Hours, which is the Time by a true going Pendulum.

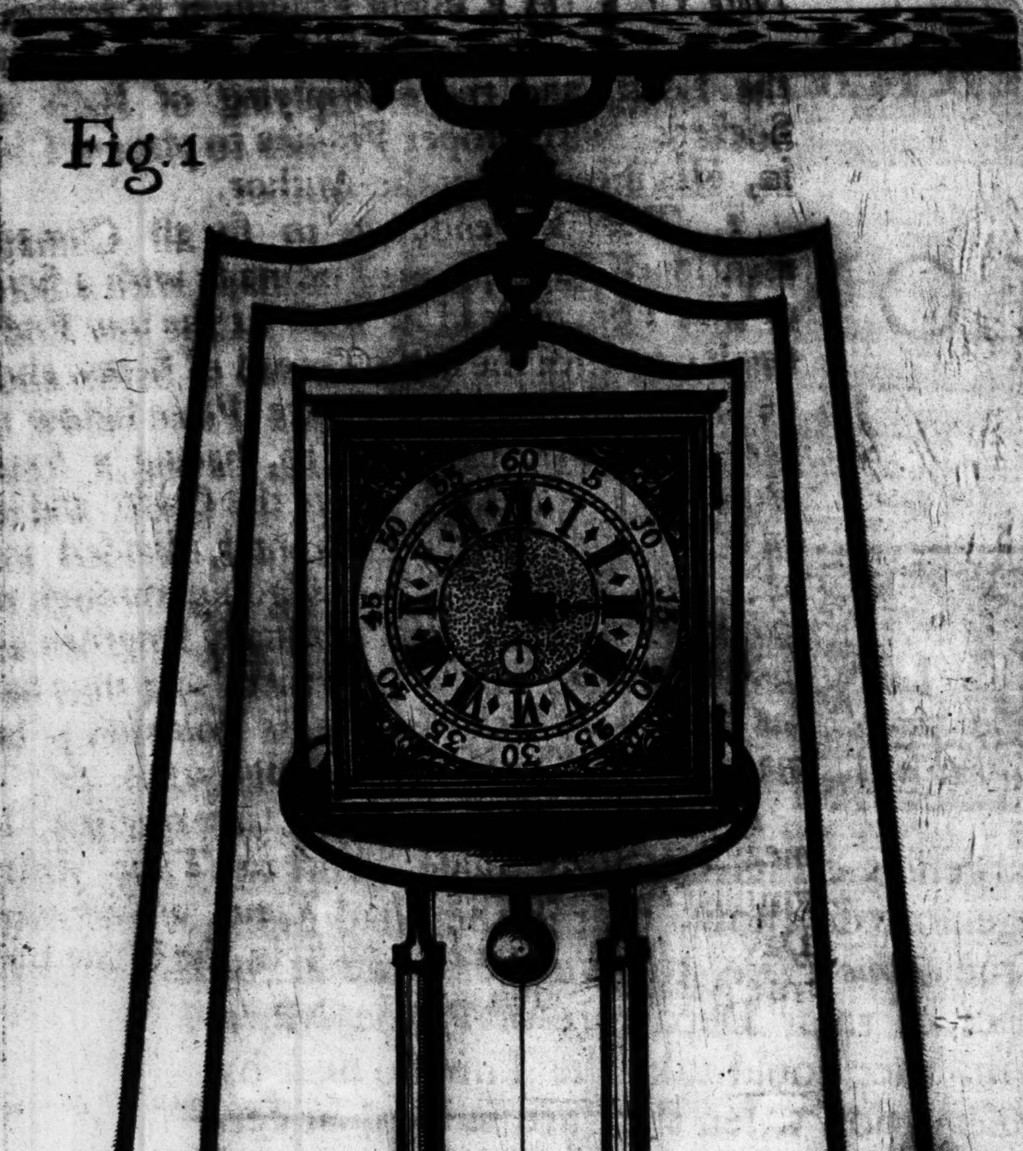
Errors.

P*Age* 10. *Line* 8. *read* the Need. *p.* 12. *l.* 5. *r.* ſetting near the Equinox. *p.* 29. *l.* 15. *r.* 1 min. 23 ſec. *p.* 34. *l.* 17. *for* Deg. *r.* Hour. *p.* 38. *l.* 2. *r.* to draw. *l.* 4. *r.* of Air.

What other literal Faults thou find'ſt, kind Reader, pray correct with thy Pen.

LONGI-

Fig. 1



Jonah Crathorne.

THE LONGITUDE *Demonſtrated.*

I Need not tell the ingenious Mariners that the Earth is Spherical, becauſe the frequent Uſe of the Quadrant teacheth them the Roundneſs thereof, as well as the Largeneſs of its Circumference: And the ingenious do allow, that if they had but a True *Time-Piece*, to give the Time at the Place of their Departure or Prime Meridian, they could take the Time ſo near by Obſervation when they are at Sea, at certain Opportunities, that they could find the Difference of Longitude much nearer than ever was heretofore known; and thereby could correct their *Dead-Reckoning*, if Erroneous. For this Purpoſe many Ways have been invented, and moſt (if not all) of them to no Purpoſe; becauſe it requires very exact Time-keeping, which they ſaid could not be performed but by a long *Pendulum*. This hath been the Opinion of the Greateſt Men of this and preceeding Ages.

I being often in Company with ſome of theſe ingenious Men, was willing to put in my Mite; and having a Senſe of Need of ſuch a Machine, began about Twelve Years ſince, and at laſt my Thoughts fell upon applying of a *Silent Pendulum*, which ſhould give True Time and Equal Vibrations, altho' the Machine ſhould Decline 30 Degrees or 40 Degrees from the Perpendicular, and equal again in the Perpendicular with proper Frames to place it in a Ship, as may be ſeen in the foregoing Diagram.

Being furniſhed with ſuch a Machine truly adjuſted (the Method I ſhall ſhew hereafter) to give the Time at the Place of Departure; we muſt alſo have the Time where the Ship is, which muſt be done either by the Sun or Stars.

It may be demonſtrated from the Principles of Diopticks, that when the Sun is apparent in the Horizon, he is at that time below the Horizon; and the neareſt Eſtimate for finding the True Time of Sun-riſe is when the lower Verge of the Sun is in the Horizon, and the ſame for its Setting; (but ſuch Demonſtration may be omitted in this Place:) I ſhall only lay down One Experiment which any One may try, *viz.* Take a Baſon and put a Piece of Money at the Bottom; let another Perſon hold the Piece in its Place with a Stick; then move your ſelves backward 'till you have loſt Sight of the Money, and let the other fill the Baſon with Water, then will you ſee the Piece of Money again.

This Method may be as exact as taking the Beginning and Ending of the Sun's Riſing or Setting, and the Minutes and Seconds that is between the Beginning and Ending multiplied by 2, and adding half to the Beginning when purged by *Refraction*, which is accounted 33 Minutes and a quarter of Diſtance; and the half Minute for the Horizontal Parrallax is ſubtracted, it will be 2 Minutes 13 Seconds of Time, which comes nearly Equal to the loweſt Edge, being juſt in the ſenſible Horizon when the *Center* is in the Rational Horizon.

N. B. This Method is very well to 50 deg. and upwards on each ſide the Equator, and will do to 60d. or 66d. while the Riſing and Setting are not too tedious to attend with its continuing ſo long in the Horizon.

As for Fixed Stars, to the Apparent Riſing add 2 min. 13 ſec. and from the Apparent Setting ſubtract 2 min. 13 ſec. and that will give the True Time of any Star's Riſing or Setting.

N. B. The Fixed Stars make their Revolutions ſooner than the mean Motions of the Sun by 3 min. 56 ſec. 30 thirds *per* Day; ſo that if a Fixed Star ſhould Riſe, Set, or come to the Meridian at the ſame time it did the Night before (being in the ſame Latitude) it is near a Degree of Weſt Longitude; and if it ſhould be more than 3 min. 56 ſec. 30 thirds ſooner than it was the Night before, it is ſo much Eaſt Longitude, allowing for every 4 min. of Time a Degree, which is 60 *Geographical* Miles at the Equator, and always leſs towards either of the Poles, according to the Table which ſhews how many Miles and Parts of a Mile correſpond to a Degree of Longitude, or 60 Minutes in the Equinox at every Degree of Latitude to either Pole of the World.

But the Latitude muſt be found (before the Time of the Day can be known) which the Ingenious Mariner is well acquainted with: However, I ſhall give an Example or Two of taking the Sun or Stars Meridian Altitude, which being ſubtracted from 90 deg. 00 min. leaves its Zenith Diſtance, to which add the Sun or Stars Declination and it gives the Latitude, if the Obſervation and Declination are both North or both South, and the Declination leſs than the Latitude.

If the Sun or Stars Declination is greater than the Latitude, ſubtract its Altitude from 90 deg. 00 min. and the Remainder is the Zenith Diſtance, which ſubtracted from the Declination gives the Latitude: But if one be North and the other South, then ſubtract the Declination from the Zenith Diſtance, the Remainder is the Latitude. This Rule holds Good, as by Example will appear.

Example. Suppoſe on the 1*ſt* of *Auguſt*, 1718; *Alcair*, the bright Star in the *Eagle*, Culminates at 10 h. 11 m. *P. M.* its Altitude 46 deg. 36 min. which ſubtracted from 90 deg. 00 min. gives 43 d. 24 m. for the Zenith Diſtance, to which add 8 deg. 08 min. the Stars Declination, that Sum is 51 deg. 32 min. Equal to the Latitude North.

Diſt. of Zen. *from the Horiz.*	90d.	00m.
Stars *Meridian Altitude* ———	46	36
Remainder ———————————	43	24
Stars *Declination, Add* ———	08	08
The Sum is the Latit, *North*	51	32

Examp.

Example 2. Suppoſe the Star *Rigel*, in the Foot of *Orion*, Culminates at 6 h. 44 m. *P. M.* (on the 11*th* of *February*) whoſe Altitude is 29 deg. 54 min. which ſubtracted from 90 deg. 00 min. there remains 60 deg. 06 min. for the Zenith Diſtance, from which ſubtract the Declination 8 deg. 34 min. and it leaves 51 deg. 32 min. the Latitude North.

Diſt. of Zen. *from the Horiz.*	90d.	00m.
Stars *Meridian Altitude*	29	54
Remains	60	06
Stars *Declination*	08	34S.
The Remainder is the Latit.	51	32N.

If you obſerve any Star nearer the Pole than the *L*atitude you are in, you turn your Backs to the Equinox to take its Altitude, which being ſubtracted from 90d. 00 m. the Remainder is the Zenith Diſtance, which being ſubtracted from the Stars Declination, the Remainder is the Latitude.

Examp. 3. *Allore*, the brighteſt Star in the *Harp*, being on the Meridian in the North of *Jamaica* at 3 h. 59 m. *A. M.*

Diſt. of Zen. *from the Horiz.*	90d.	00m.
Stars *Meridian Altitude*	59	27
Stars *Zenith Diſtance*	30	33 N.
Stars *Declination*	48	33 N.
Latitude	18	00 N.

Then if the Latit. of the Place and Sun's Declination be known, the true Time of the Sun's Riſing or Setting may be found by this Proportion, *viz.*

As the Radius is to the Tang. of the Lat. So is the Tang. of the Sun's Dec. To the Sine of the Sun's Difference of Aſcenſion.

Which being converted into Time by allowing 15 deg. to an Hour, and 15 min. of Diſtance to one in Time, it will ſhew how much the Sun Riſes or Sets before or after Six, obſerving the two following Rules.

1*ſt*. If the Latitude of the Place, and Sun's Declination, be on the ſame Side of the Equinox, that is, both North or both South, then from 6 Hours ſubtract the Aſcenſional Difference, the Remainder is the Time of Sun-riſe, and added to 6 Hours, gives the Time of his Setting.

2*d*. If the Latitude of the Place, and Sun's Declination be one North the other South, then the Aſcenſional Difference being added to 6 Hours, gives the time of Sun-riſe, and ſubtracted from 6 Hours gives the time of Sun-ſet.

Concerning the Uſefulneſs of Fixed Stars in Diſcovering the Longitude.

Fixed Stars are Regular in their Motion, being 3 min. 56 ſec. 30 thirds in their Revolution or Syderial-Day, leſs than the mean Solar Day; therefore I have Calculated a Table of their daily Difference from 1 to 30 Days.

Suppoſe a Ship when at or near ſome known Place where any Remarkable Star ſhould Riſe or Set, and keeping a true Account what the Machine was at when the Star did Riſe or Set, and ſet down the Day of the Month, Hour, Minute and Second of that Star's Riſing or Setting; and at any Number of Days after, when the Star comes again to the Horizon, obſerve the time by the Machine: Then compare Riſing with Riſing and Setting with Setting, allowing for Alteration of Latitude as ſhall be hereafter directed: And if the time by the Machine at the ſecond Obſervation exceed the firſt, ſubtract the firſt from it, and to the Remainder add the Number for the Days that is between the Obſervations as is found in the Table, and it is Weſt Longitude. But if the firſt exceed the ſecond, ſubtract the ſecond from it, and if the Remainder be greater than the Number for the Days that is between the Obſervations, ſubtract the Number of daily Difference from the Remainder, and that Remainder is Eaſt Longitude.

But if the Remainder be leſs than the Number found in the Table; ſubtract the

Remainder from the daily Difference, and what remains is Weſt Longitude, as ſhall be explained hereafter, where I ſhall give an Example or two, how they are applied.

A Table of the fixed Stars Revolution,

By which may be found how much the Solar Day is longer than the Siderial, and thereby may regulate the Pendulum; and when well rectified, by obſerving the Riſing or Setting of any Star in any Number of Days from 1 to 30, at the ſecond Obſervation, it diſcovers the Difference of Meridians.

Days	*Hours*	*Min.*	*Sec.*	*Days*	*Hours*	*Min.*	*Sec.*	*Days*	*Hours*	*Min.*	*Sec.*
1	0	3	56	11	0	43	21	21	1	22	46
2	0	7	53	12	0	47	18	22	1	26	43
3	0	11	49	13	0	51	14	23	1	30	39
4	0	15	46	14	0	55	11	24	1	34	36
5	0	19	42	15	0	59	07	25	1	38	32
6	0	23	39	16	1	03	04	26	1	42	29
7	0	27	35	17	1	07	00	27	1	46	25
8	0	31	32	18	1	10	57	28	1	50	22
9	0	35	28	19	1	14	53	29	1	54	18
10	0	39	25	20	1	18	50	30	1	58	15

How to Rectify a Pendulum by this Table.

Fix a Telleſcope with croſs Hairs, in ſome convenient Place where a fixed Star paſſeth by in the very croſſing of the Hairs, then ſet down the Hour, Minute, and Second as near as poſſible, and ſome Nights after, obſerve the ſame Star paſſing by the croſs Hairs; then take the Number for the Days that was between the two Obſervations that is found in the Table, and ſubtract that Number from the firſt Obſervation; and if the Remainder be equal to the ſecond, the Clock goes true according to the Sun's mean Motion: But if the Remainder be more than the Time ſhewn by the Clock at the ſecond Obſervation, the Pendulum goes too ſlow; if leſs the Pendulum is too faſt, by the Difference that is between them, ſo ſcrew it up or down until the Pendulum be adjuſted.

If one hath a Window to put a Sight where any Fixed Star, that is remarkable paſſes by the Edge of a Chimney near the South, at 20 or 30 Yards Diſtance, it will do inſtead of a Telleſcope.

A Table, ſhewing how many Miles of the Equator *make a Degree of Longitude in any Latitude.*

Note, The following Table is thus Conſtructed.

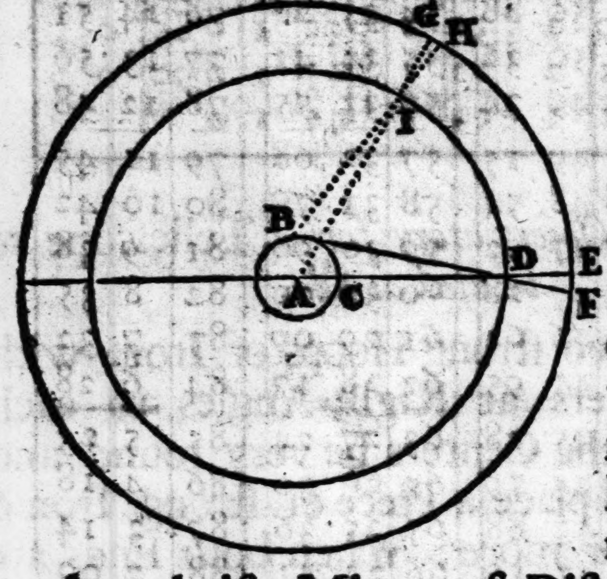
As the Radius is to the Sine Complement of the Latitude, So is 60 Miles equal to one Degree in the Equator to the Reſponding Miles in a Degree in that Latitude.

Lat.	*Miles*	*Parts*	*Lat.*	*Miles*	*Parts*	*Lat.*	*Miles*	*Parts*	*Lat.*	*Miles*	*Parts*
1d	59	99	23	55	23	45	42	43	67	23	45
2	59	96	24	54	81	46	41	68	68	22	48
3	59	92	25	54	38	47	40	92	69	21	50
4	59	86	26	53	93	48	40	15	70	20	52
5	59	77	27	53	46	49	39	36	71	19	54
6	59	67	28	52	97	50	38	57	72	18	55
7	59	56	29	52	47	51	37	76	73	17	54
8	59	42	30	51	96	52	36	94	74	16	53
9	59	26	31	51	43	53	36	11	75	15	52
10	59	08	32	50	88	54	35	26	76	14	51
11	58	89	33	50	32	55	34	41	77	13	50
12	58	68	34	49	74	56	33	55	78	12	48
13	58	46	35	49	15	57	32	68	79	11	45
14	58	22	36	48	54	58	31	79	80	10	42
15	57	95	37	47	92	59	30	90	81	9	38
16	57	67	38	47	28	60	30	00	82	8	35
17	57	37	39	46	62	61	29	09	83	7	32
18	57	06	40	45	95	62	28	17	84	6	28
19	56	73	41	45	28	63	27	24	85	5	23
20	56	38	42	44	59	64	26	30	86	4	18
21	56	01	43	43	88	65	25	36	87	3	14
22	55	63	44	43	16	66	24	41	88	2	09
23	55	23	45	42	43	67	23	45	89	1	05

A

A Table of Refractions, that are to be obſerved and ſubtracted from the Altitude, and added to the Zenith Diſtance *in Obſervations of the Sun or Stars, in order to find the true Altitude or* Zenith Diſtance.

As for the Horizontal Parallax, it is ſo ſmall that it's ſcarce worth Notice, being but half a Minute of Diſtance at the Horizon, and leſs as the Altitude is greater. So leaving out half a Minute of the Refraction at the Horizon, the true Refraction at the Horizon will be 33 m. and a quarter.



The Horizontal Parallax, is the difference between the Senſible and Rational Horizon, which ſhews it ſomething lower than it really is by about half a Minute of Diſtance, or Two Seconds of Time, as ſuppoſe ABC the Earth, the Sun at D, A the Center of the Earth, then it is evident if the Eye be at B, the Sun at D will appear at F, and the Horizontal Parallax, *viz.* The *Angle* EDF is greater than GIH, or any other, &c. *De-*

Degrees	Refract.	Degrees	Refract.	Degrees	Refract.	Degrees	Refract.	Degrees	Refract.
D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
Ho	33 1/4	11	4 2/5	22	2 1/6	33	1 1/3	44	1 0
1	23 1/10	12	4 0	23	2 1/12	34	1 1/3	45	0 6/7
2	17 1/8	13	3 3/4	24	2 0	35	1 1/4	50	0 3/4
3	13 1/3	14	3 1/2	25	1 6/7	36	1 1/5	55	0 2/3
4	10 4/5	15	3 1/4	26	1 5/6	37	1 1/6	60	0 1/2
5	9 0	16	3 0	27	1 3/4	38	1 1/7	65	0 2/5
6	7 1/4	17	2 5/6	28	1 2/3	39	1 1/18	10	0 1/3
7	6 3/4	18	2 3/4	29	1 3/5	40	1 1/15	75	0 1/4
8	6 0	19	2 1/2	30	1 1/2	41	1 0	80	0 1/6
9	5 1/2	20	2 2/5	31	1 1/2	42	1 0	85	0 1/12
10	4 3/5	21	2 1/3	32	1 2/5	43	1 0	90	0 0
11	4 2/5	22	2 1/6	33	1 1/3	44	1 0		

To make an Obſervatory for a Telleſcope *to be uſed at Sea.*

Make Two ſtrong Hoops of Iron, with Croſs Centers at Right-Angles to each other; let the Centers be very round and ſtrong, and place a Piece of ſtrong Iron 6 Foot long or more: When both Ends are firmly ſcrew'd or faſtened to the inner Circle as perpendicular as poſſible; let each Side be 6 Foot or more, with a very great Weight caſt on the low End of it, 5 or 6 Hundred or more, the greater the better; then having a very ſtrong Frame with 3 Feet, or as your Conveniency ſerves to place the outward Centers in (as in *Fig.* 3.) Theſe Circles being ſo wide as when a Man is in them, he may have on the level Board, which is fixed to the innermoſt Circle, his Quadrant or Telleſcope on the level Board, which may be known when it is ſo by the two Plumb Lines: Let a Man go into it having a Place for his Feet, that he may have his Arms ſo high above the Board, as to uſe the Inſtrument and take an Obſervation. When he hath fixed himſelf therein, his Attendants muſt ſee by the Plumb Lines when the Board is level by the Iron being perpendicular, and they muſt have Weights to add as they ſee Occaſion; then the Greatneſs of the Weight will keep the Board Horizontal in any moderate Weather, and you may take an Obſervation nearly, if not fully as true as at Land.

Fig. 2. Is the *Sun-Quadrant*, commonly called *Davis*'s Quadrant, with which and this Obſervatory, you may take an Obſervation when you cannot ſee the Horizon, if the Sun do but appear without ſtraining the Eye, at leaſt when it is prepared according to the following Directions.

This Quadrant, which is an excellent Inſtrument, and of great Uſe, only in hazey Weather the Horizon cannot be ſeen, altho' the Sun ſometimes appears pretty clear a conſiderable Diſtance above; yet to make this Inſtrument more uſeful, I have not only invented the Obſervatory for the Obſerver, and the Inſtrument to keep the true Horizon but an additional Level to the Inſtrument, which is thus. Let there be inſtead of the Eye-Vane, a ſquare Piece of Wood with a true Slit the Length of the Quadrant to go upon a Joynt at the Center, and of that Wideneſs that the Arch of 30 may freely paſs through, and the Edge truly bevelled to ſhew the Degrees more exactly; if they pleaſe they may put a Sight or Eye-Vane on the ſide of this Frame, but the Uſe of it is intended to place it level upon the Board of the Obſervatory, that this true Frame may be exactly Horizontal, and the great Weight keeping it ſo, you have nothing to do but to raiſe the Arch of 30 d. with your Hands until the Sun be at its Height, which you may eaſily perceive by the firſt Declining which is in the Slit of the Horizontal Vane, by the Rays from the Shadow Vane, having nothing elſe to mind with your Eyes. The Degrees and Minutes are contained between the Shadow Vane and the Edge of the Frame in the Two Arches.

It was an ingenious Thought of *John Ward*, to have a Spirit Level to find the

Horizon, but the Difficulty was the moving of the Ship before the Obſerver was aware caſt it to one End, but fixed in this Inſtrument may keep it with Eaſe ſo equal that the Break may reſt in the middle. And it may revive this ingenious Invention with Credit to its Author, for I would not have any uſeful Invention (that may be ſerviceable to the Publick) loſt, that I am capable of retrieving, but wiſheth every ingenious Man may have the Credit due to his Invention, and not take to my ſelf that which is due to another; for I own that the Spirit Level to this Quadrant was not my Invention but the ſaid *John Ward's*, and I hope the inginious Man will excuſe me if I make Uſe of it; for my way is the Plumb Line, and ſo, which is found of the greateſt Service may be moſt followed, for I beleive either Way will be of great Uſe both by Land and Sea, in taking the Sun's Altitude. I never did ſee that with Spirits, but had the Account from one that had ſeen it, and ſeems very reaſonable it ſhould be of Service.

The Index Inſtrument is to be taken in hand at the time of Obſervation, and ſet the Hour and Minute Indexes that have not the Sun upon them to the *Machine*, and keeping them equal with it, until the Obſerver of the Sun give them the Word to leave them ſhewing the time of Sun Riſing or Setting to a Second or Two, they remaining there, as in *Fig.* 4. The other Indexes with the Sun's Figure; being ſet by Calculation for that Day's Sun-ſetting or Riſing (as in *Fig.* 4. of Sun-ſet) bring the Indexes of the Sun from the apparent Time to the true Time, by putting it backward or forward as the Tables of Equation directs, there being two Circles for the Minute Indexes; the one numbred forward, and the other backward, for the more ready adding and ſubtracting as the Table of Equation directs.

In the Minute and Second Circles of the Sun's Indexes is a little Dart to ſhew where the Indexes ſtood by apparent Time before the Equation of that Day was added or ſubtracted (as in *Fig.* 4.)

The Indexes ſet by the Machine, ſhews the true time at the *Prime Meridian,* and thoſe with the Figure of the *Sun,* the time where the Ship is; thoſe to the Machine at 1 min. 23 ſec. paſt One; and the other with the *Sun-Mark* at 50 min. 23 ſec. paſt 5 of the Clock, after the 55 ſec. was added, being the Equation for the 10*th* of *June*. Then obſerve betwixt the Indexes, and there is 4 h. 49 m. or in Degrees is 72 deg. 15 min. as may be ſeen by the ſaid Inſtrument, having a Circle divided into 180, which repreſents one half of a Sphere, and from 12 divide both ways to 90 deg. 00 min. each repreſenting the Quadrant. Therefore when one Index is ſet to the true Time at the Place of Departure, and the other at the true Time where the Ship is, it doth not only ſhew the Difference of Time, but the Difference of Longitude in Degrees and Minutes exactly (by *Fig.* 4 and 5) the one ſhewing it to be Eaſt Longitude, by the Sun's being before the Machine, and the other ſhewing it to be Weſt Longitude, by the Machine being before the Sun.

It is called an Index Inſtrument, from having ſo many Indexes, which clearly demonſtrates that the Difference of Meridians is diſcovered by Time-keeping, even made plain to the meaneſt Capacity; for each Hour is divided into 15 deg. in the Inſtrument equal to time, and Diſtance in the Equinox; for it is vulgarly ſaid that the Sun makes one compleat Revolution round the Earth in 24 Hours, therefore divide 360 by 24, the Quotient will be 15 deg. equal to one Hour of Time.

Example 1. *Suppoſe a Ship from* London *is bound for* Fort St. George *in the* Eaſt Indies, *whoſe Latitude is computed* 13 *deg.* 08 *min. North, and Difference of Meridian or Time* 5 *Hours*, 27 *Minutes*, 30 *Seconds, or* 81 *deg.* 56 *min.*

So ſailing down the River, *January* 10*th*, 1718, and paſſing by the Obſervatory at *Greenwich*, ſet the Machine to true Time, and there begin the Longitude; for the Conveniency of good Time-Pieces that are kept there: So proceeding until the 20*th* of *February*, and at 6 Minutes paſt 4 in the Morning, the Norther Scale of the Ballance is on the Meridian, its Altitude being 66 deg. 43 min. which being ſubtracted from 90 deg. 00 min. the Remainder is 23 deg. 17 min. the Star's Zenith Diſtance, from which ſubtract the Star's Declination, 8 deg. 17 min. South, and it leaves 15 deg. 00 min. the Latitude North; and at Sun-Riſe having decreaſed the Latitude 00 deg. 04 min. it is thus, the Sun's Declination increaſing 23 min. *per* Day, and at the Sun-Riſing where the Ship is, the Declination is 6 deg. 46 min. it being 4 Hours and almoſt a half before the Sun be on the Meridian at *Greenwich*, where the Tables of Declination are calculated for; and the Declination is then on the Meridian 6 deg. 50 min. ſo ſubtracting 4 min. for the 4 Hours, it is ſooner than at *Greenwich*, being the ſixth part of 24 Hours, and it is 6 deg. 46 min. which is thus.

	d m	
As the Radius, ——	90.00	10.0000000
Is to Tang. *Lat.*	14.56	9.4260271
So is T. *of Suns Dec.*	6.46	9.0742779
Sine diff. of Aſcen.	1.49	18.5003050

Which being converted into Time, is 7m. 16 ſec. which being added to 6 Hours gives 6 h. 7 m. 16 ſec. to which add 12 min. 22 ſec. (for the Equation) it makes 6 h. 19 m. 38 ſec. which muſt be ſubtracted from 7 h. 49 m. 38 ſec. and there remains 1 h. 30 m. which is 22 deg. 30 min. Weſt Longitude from *Greenwich*; and proceeding S.E. by S. until the firſt of *April*, when you touch at Cape *Bone Eſperance*, then having an Obſervation of the Sun on Shoar, and finding 44 ſec. paſt 12, which (44 ſec.) ſubtract for the Equation, there remains 12 of the Clock, and the Machine being 41 min. paſt 10, which ſubtract from 12 of the Clock there remains 1 h. 19 m. which ſhews the Machine to goe true; it being 19 deg. 45 min. Eaſt of *Greenwich*. Thus,

True time at the Cape	12h.	00m.	00ſe.
True time by the Machine at Greenwich.	10	41	00
Difference of Time, ——	01	19	00

which is 19 deg. 45 min. which you muſt ſet down; and at every known Place ſhould be examined and ſet down as if it was a New Meridian. So proceed until the 10*th* of *June*, and at Noon take the Sun's Meridian Altitude being 60 d. 16 m. that ſubtracted from 90 deg. 00 min. gives 29 deg. 44 min. for the Sun's Zenith Diſtance; from which ſubtract 23 deg. 29 min. for North Declination the Remainder is 6 deg. 15 min. the Latitude South. So proceed until Sun-Set, and by the Dead Reckoning have decreaſed the Latitude 12 min. but the Declination is the ſame as at Noon, the Sun being then on the Tropick, and at Sun-Set finds the Machine one min 23 ſec. paſt 1 of the Clock. Then,

	d. m.	
As the Radius ———	90.00	10.0000000
Is to the T. *of Lat.*	06.03	9.0252510
So is T. *of Suns Dec.*	23.29	9.6379563
To the diff. of Aſcen.	02.38	18.6632073

Which converted into Time; is 10 m. 28 ſec. that the Sun Sets before Six.

Is———————	5h.	49m.	28ſe.
To which add the Equation	0	00	55
The Sum is———————	5	50	23
From which ſubtract the Time by the Machine,	1	01	23
There Remains ———	4	49	00

Which anſwers to 72 deg. 15 min. the Ship is in Eaſt Longitude from *Greenwich*; (as in *Fig.* 4.)

And 52 deg. 30 min. from the Cape.

Example 2. *Suppoſe a Ship from* London, *is bound for* Port-Royal *in the Iſland of* Jamaica, *whoſe Latitude is computed* 17 deg. 40 min. *Difference of Time* 5 h. 4 min. *and* 76 *deg. Weſt: So ſetting the Machine to true Time at the Obſervatory of* Greenwich, March 1ſt, 1718; *then proceed until the* 20th *of* April *in the Morning, and* 59 *min. paſt* 3 *of the Clock finds the Bright* Star *in the* Harp *on the Meridian; its Altitude being* 59 *deg.* 27 *min. therefore the Star's Zenith Diſtance is* 30 *deg.* 33 *min. which being ſubtracted from the Star's Decilnation, the Remainder is the Latitude. Thus,*

	90d.	00m.
Stars Meridian Altitude	59	27
Stars Zenith Diſtance	30	33
Stars Declination	48	33
The Remainder is the Lat. N.	18	00

So keeping Reckoning until Sun-Riſe, and the Sun's Declination for that Day is 15 deg. 02 min. when on the Meridian of *Greenwich*; and increaſing 17 min. *per* Day, our Courſe being Weſt, we have not altered the Latitude, but muſt ſubtract

2 min. from the Declination, for the Time from Noon at *Greenwich*, and the Declination is 15 deg. 00 min. where the Ship is. Then,

	m. d.	
As the Radius ——	90.00	10.0000000
Is to the T. *of the Lat.*	18.00	9.5117760
So is T. *of Suns Dec.*	15.00	9.4280525
To Sine of diff. Aſcen.	5.00	18.9398285

Which being converted into Time, is 20 min. that the Sun riſeth before 6, which is 40 min. after 5; and the Equation being (3 min. 15 ſec.) ſubtracted from it, there remains 5 h. 36 m 45 ſec. the true Time; and by the Machine it is 6 min. 45 ſec. paſt 8 at *Greenwich*.

Time at Greenwich ——	8h.	06m.	45ſe.
Time where the Ship is ——	5	36	45
Difference of Time ——	2	30	00

Which anſwers to 37 deg. 30 min. Weſt. So proceed until the 10*th* of *May* at Noon; and then find the Sun's Meridian Altitude to be 87 deg. 27 min. which ſubtract from 90 deg. 00 min. the Remainder is 2 deg. 33 min. for the Zenith Diſtance: The Declination increaſing 12 min. *per* Day; the Declination at *Greenwich* that Day at Noon is 20 deg, 11 min. to which add 2 min. for the Computation Weſterly, and it is 20 deg. 13 min.

The Merid. Dec. where the Ship is	20d.	13m.
Suns Zenith Diſt. ſubtract	02	33
Latitude North	17	40

Then ſailing Weſt until Sun-Set, and the Declination increaſing 3 min. in 6 Hours at 12 min. *per* Day more than it was at Noon; it is 20 deg. 16 min. Then,

	d. m.	
As the Radius	90.00	10.0000000
Is to the T. *of Lat.*	17.40	9.5031092
So is T. *of Suns Dec.*	20.16	9.5673205
To Sine of diff. Aſcen.	6.45	19.0704297

Which being converted into Time is 27 m. ſo much the Sun Sets after 6, and Equation being 4 min. 4 ſec. ſubtracted from 6 h. 27 m. there remains 6 h. 22 m. 56 ſec.

The time at Greenwich *by the Machine is*	10h.	34m.	56ſe.
True Time where the Ship is	06	22	56
The Difference of Time	04	12	00

Which converted into Degrees is 63 deg. Difference of Longitude Weſt from Greenwich (as in *Fig.* 5.)

A farther Explanation of the Uſefulneſs of the Fixed-Stars in diſcovering the Longitude.

Suppoſe a Ship was ſailing by the *Lizard-Point*, the 10*th* of *April*, 1718, in the Latitude of 49 deg. and at 8 min. 30 ſec. paſt 9

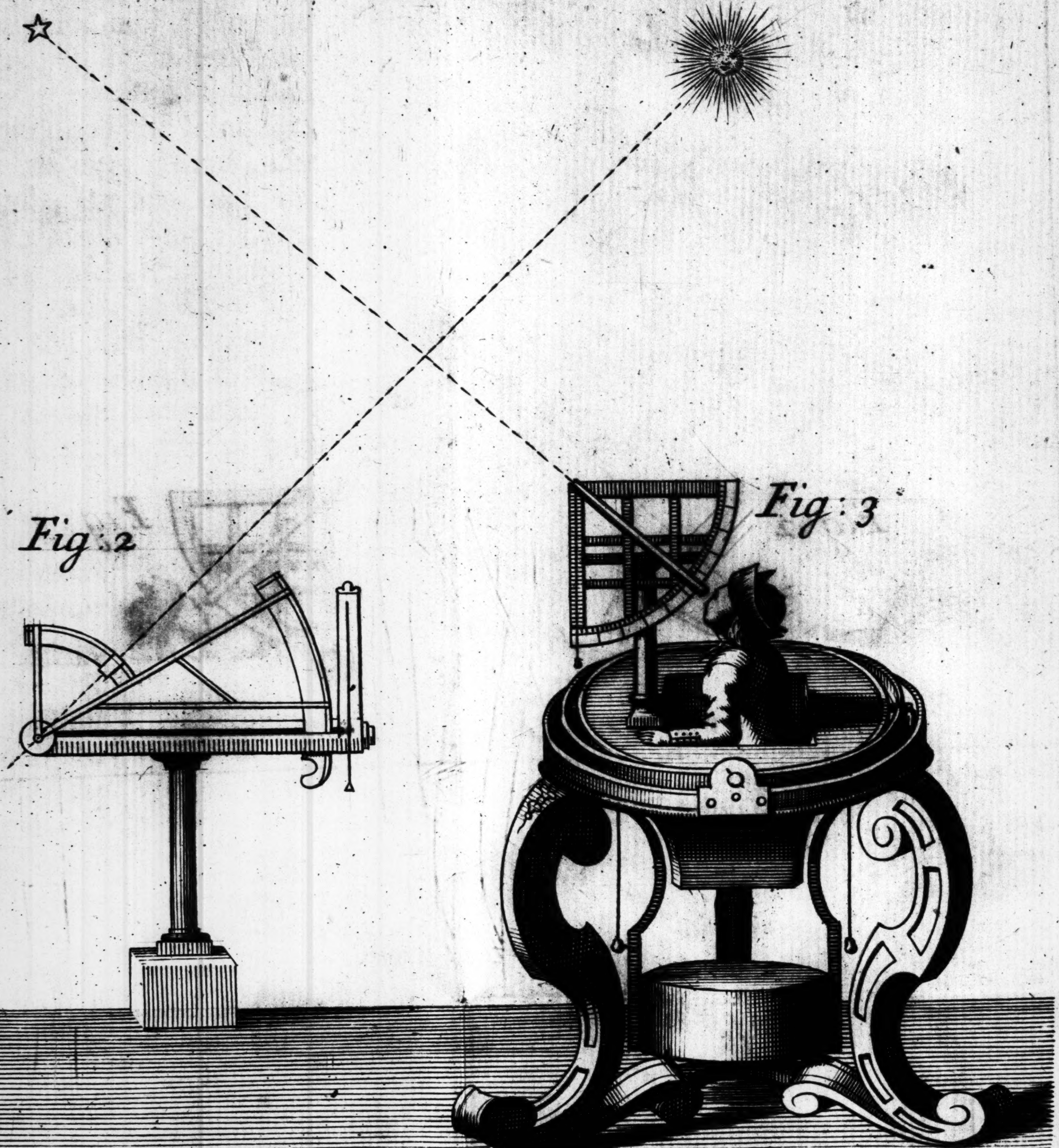


Fig: 2

Fig: 3

Jon:

Fig: 4

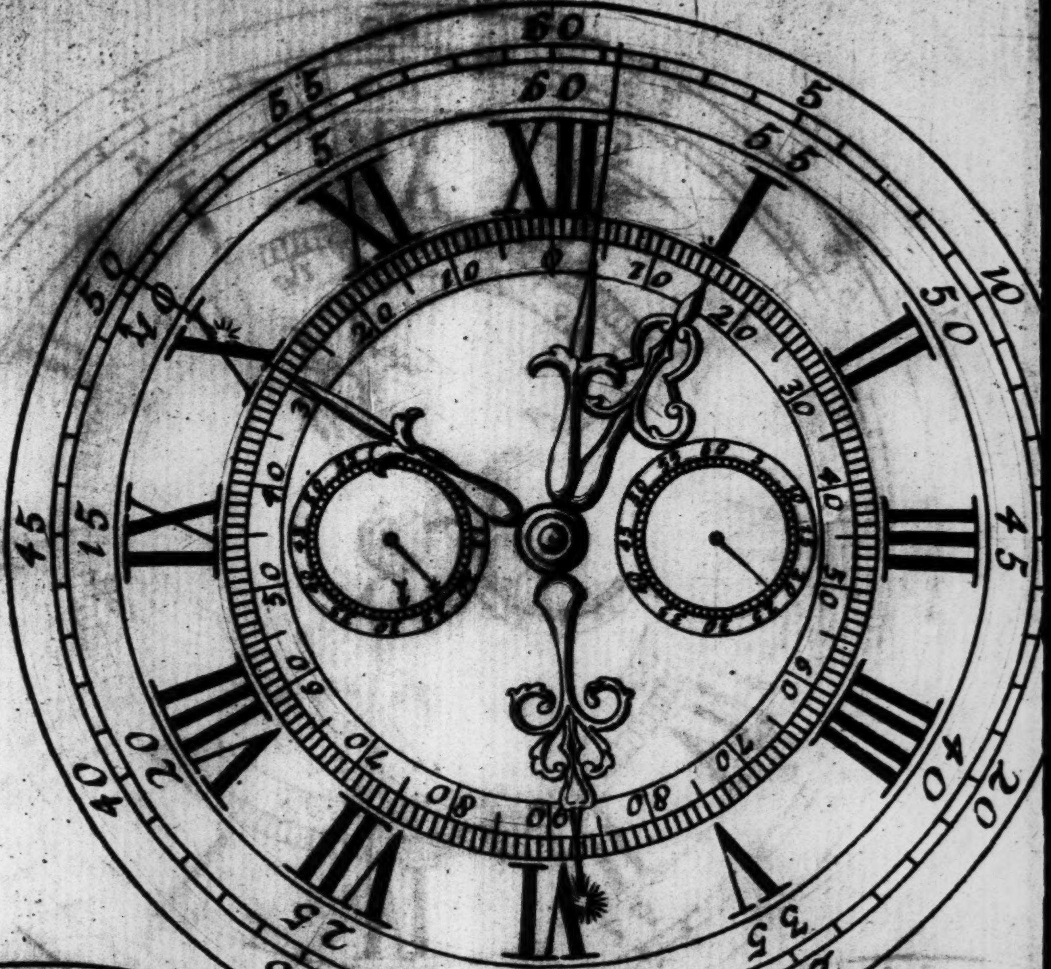
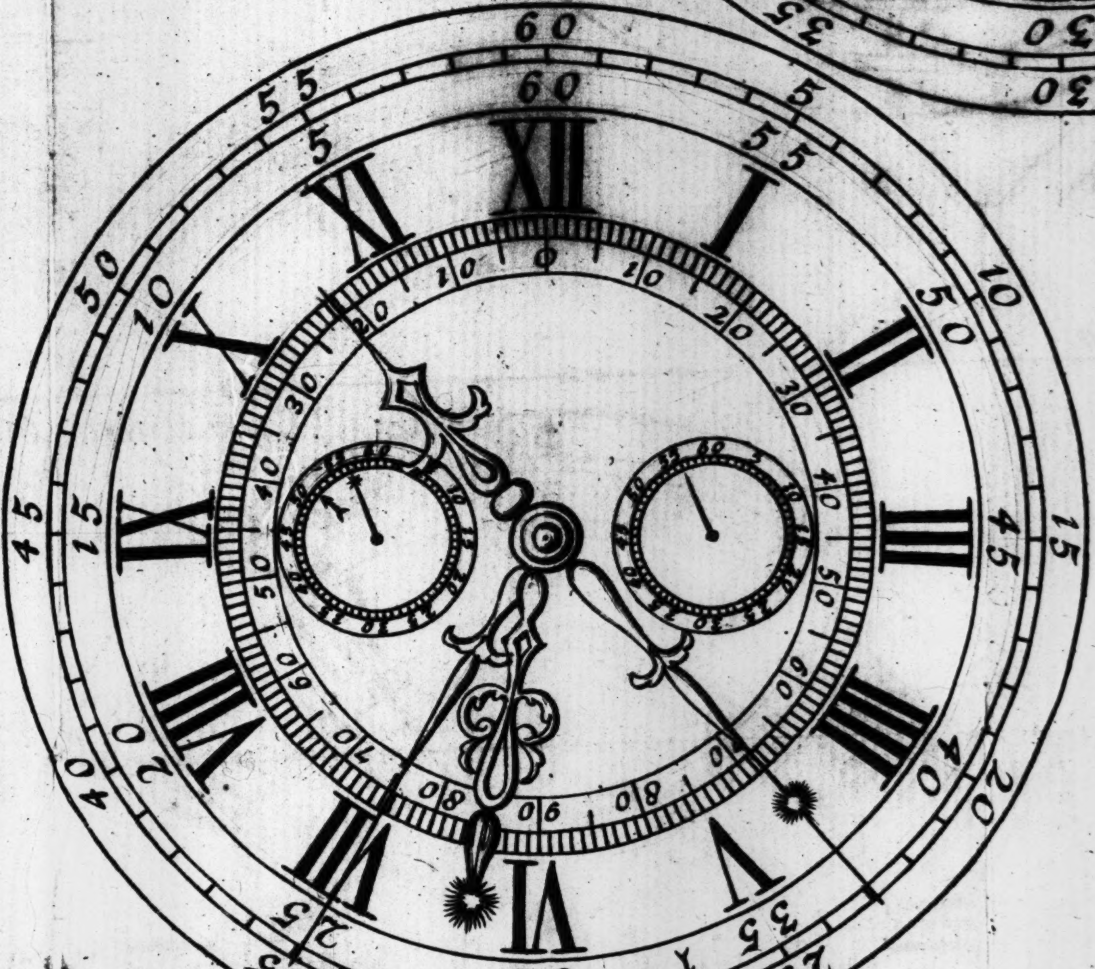


Fig: 5



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by the Machine; in the Evening finds the firſt Star in *Orion's-Belt* Setting, and by Reckoning is juſt under the Meridian of the *Lizard*: Place down the Day of the Month, the Latitude and Time by the Machine, and ſo proceed until the 10th of *May*, (intending for *Barbadoes*) whoſe Latitude is computed 13 deg. 30 min. and Difference of Meridian, or Time 3 h. 53 m. and Difference of Longitude 53 d. 10 min. Weſt; and in the Evening you find the ſame Star Setting in Latitude 18 deg. North, the Machine being 12 min. 23 ſec. paſt 10, and finding by the Tables of Sines, Tang. &c. it ſets later in 18 d. of Latitude than it did in 49 deg. by 2 min. 8 ſec. which muſt be added to the firſt Obſervation, or ſubtracted from the ſecond, it being the Difference between the Latitudes; ſo adding it to the firſt, it makes 9 h. 10 min. 28 ſec.

Which being ſubtr: from the time at ſecond Merid.	10h.	12m.	23ſe.
Time at the firſt Meridian	9	10	38
Remains	1	01	45
Add the Num. found in the Table of Accelerat. for 30 Days	1	58	15
The diff. of Time, which converted into deg. is 45 deg. W. from the Lizard.	3	00	00

That

That the Ship will be in at the ſecond Obſervation, and 8 deg. 10 min. Eaſt from *Barbadoes* according to the Computation.

Example 2. *Suppoſe a Ship is at any known Place, as Cape* Bone Eſperance, *in her Way to the* Eaſt Indies, *on the* 4*th of* April, 1718, *and at* 36 *min.* 32 *ſec. paſt* 11 *at Night, finds the* Dog-Star *Setting: Place it down with the Day of the Month; Latitude* 34 *deg.* 15 *min. and proceed until the* 4*th of* May, *and then find the Ship in* 20 *deg. South Latitude, and the ſame Star Setting in the Evening, the Machine being at* 45 *min.* 17 *ſec. paſt* 5; *and by the Tables of* Sines *and* Tangents, *find the ſame Star Setting ſooner in* 20 *deg. than it did in* 34 *deg.* 15 *min. by* 12 *min. therefore* 00 *deg.* 12 *min. muſt be ſubtracted from the former, or added to the latter Obſervation; ſo ſubtract* 12 *min. from the former, it being the Difference between the Latitudes, and it leaves the firſt; when* 12 *min. is ſubtracted from* 11 *h.* 36 *min.* 32 *ſec. it is* 11 *h.* 24 *min.* 32 *ſec. from which ſubtract the Time by the Machine at the ſecond Obſervation, which is* 5 *h.* 45 *m.* 17 *ſec. and there remains* 5 *h.* 39 *min.* 15 *ſec. from which ſubtract the Number for* 30 *Days found in the* Table, *which is* 1 *h.* 38 *min.* 15 *ſec. and there remains* 3 *h.* 41 *min. which is thus.*

The firſt Obſervation, ——	11h.	24m.	32ſe:
The ſecond ſubtract, from it	5	45	17
Remains ——	5	39	15
From which take the Num. for 30 Days, ——	1	58	15
The Remainder is ——	3	41	00

Which converted into Degrees and Minutes, is 55 deg. 15 min. Eaſt from the Cape; which being ſubtracted from the Difference of Longitude between the Cape and *Batavia, viz.* 81 deg. 00 min. the Remainder ſhews that the Ship is 25 deg. 45 min. Weſt of *Batavia.*

Note, This Rule is always to be obſerved in finding the Difference of Meridians by the Fixed Stars; if the Machine be more at the firſt Obſervation than at the ſecond, ſubtract the ſecond from it; and if the Remainder exceed the daily Difference found in the Table of Acceleration of Fixed Stars for the Number of Days that was between them, ſubtract this Number found in the Table from the Remainder, and what remains is Eaſt Longitude; as in the laſt Example.

But if the daily Difference found in the Table, exceed the Remainder, after the ſecond is ſubtracted from the firſt; ſubtract that Remainder from the Number found in the Table, and what Remains is Weſt Longitude.

And again, if the ſecond Obſervation be more than the firſt, ſubtract the firſt from it; and to the Remainder add the Number found in the Table for the Number of Days that was between them, that Sum is Weſt Longitude.

Which being converted into Degrees and Minutes of the Equator, allowing Four Minutes of Time to One Degree; ſo ſhall the Diſtance from the firſt Obſervation to the ſecond be known, by applying to the *Table of how many Miles of the Equator make a Degree in any Latitude.*

An Examination of the Cauſes why Ballances *and* Pendulums *ſhould vary by heat of Climates, with an Experiment; and the Author's Approbation concerning the Lengthning of* Pendulums *by the heat of Climates, and Shortning in Cold; with a Method to regulate them to keep Time in all Climates where the Difference is found.*

OUR greateſt Students in Navigation and Aſtronomy, could not ſee any Way to diſcover the Longitude ſo near as by true Time-keeping; which is ſo neatly perform'd by the *Long Pendulum*:

When they had ſtudied ſeveral Ways how to make it perform the ſame at Sea that it did at Land, and had wearied themſelves with ſeeking and not finding the Method; yet ſeeing a great Neceſſity for keeping true Time at Sea, ſome of 'em returned to the Ballance, and pretended to regulate its Motion by Spyral Springs; which ſome ingenious Mechanicks before us, that was great Students, ſuch as Dr. *Hook*, the Great *Hugens*, &c. had invented, which wonderfully regulated the Motion, yet could not come ſo near as a *Long Pendulum*, nor quite ſo true as a *Crown-Wheel Pendulum*, eſpecially thoſe that have *Cycloids* far exceeds them, yet a great Advantage to what it was before; and particularly in Pocket-Watches.

The Length of *Pendulums* by our Great Men was found to be 39 Inches two Tenths to vibrate Seconds, which ſome of them called an Univerſal Meaſure, or Standard for all Places and Ages; yet we find that hotter Climates may cauſe the *Pendulum* to go ſlower by the lengthening of the *Pendulum*, which hath occaſioned ſome to ſay, that if a *Pendulum* could be made to go true in a Ship, (which they thought impoſſible) yet the Alteration of Climates would cauſe it to go faſter or ſlower, according to the heat of the Climate, which they ſuppoſed could be helped in a Ballance, by having it put in a Glaſs Veſſel made for that Purpoſe; toand draw out the Air with an Air Pump; and ſo have always one Temperature ſo Air; and conſequently keep true Time in all Places and Climates: Yet I never knew a Ballance to be relied upon for keeping true Time in any one Place, which many *Pendulums* have done; that they come within 2 or 3 min. in a Twelve. Month: And if drawing out the Air would do any Service this may have a Veſſel made cloſe to put it in if it be available: But there are other Ways to ſecure it with leſs Trouble.

I now come to the Experiment of the lengthening of *Pendulums* by heat of Climates, which I allow there is ſome Difference; but not ſo much as to make it uſeleſs in this Affair: And altho' there is a Differenee, yet it ſhall excel any Motion yet known for true Time-keeping.

Therefore to try the Experiment, I took a *Theromometer*, and a *Rod* the Length of a *Pendulum*. I gauged the Rod, and put them both into a cloſe Place, the one by the other, before I cauſed the Heat; which was gradual for ſome time, until the *Theromometer* did riſe above 50 deg. more than it was at firſt, which I take to be as great as the Difference between 51 deg. 32 min. and the Equinox: I gauged the Rod, and computed it to be a hundredth Part of an Inch longer than at the firſt; which if it ſhould have continued ſo for 24 h. it would have gone 10 ſec. ſlower than it did before: But as I underſtand ſuch Heat does not continue under the very Equinox ſo hot above one quarter of the Day and Night; for the Sun is but 45 deg. of Altitude at 9 in the Morning, and 3 in the Afternoon; ſo that the Earth has time to cool, being the Sun lies 12 h. under the Horizon; ſo that if a *Pendulum* be made as it ought to be, it will be 3 or 4 ſec. *per* Day too ſlow about the Equinox, if it went true here.

What I have ſaid, will be diſliked by ſome ingenious Mathematicians, that have found 14 or 15 ſec. *per* Day ſlower in the heat of Summer than in the cooleſt of Winter, which I will not deny; but am of Opinion that the lengthening of the Pendulum did not cauſe all that Difference, but the Pendulum Rods weakening by Heat, and ſtrengthening by Cold; makes much more Difference than the lengthening and ſhortning: for I beleive every ingenious Artificer upon due Conſideration, will agree with me in this Point, and own that Mettals with Heat will weaken much more than they lengthen; and therefore Pendulums ſhould be ſo made that they may not yield any where but at the Point of Suſpenſion, and then they ſhall find very little Variation between Summer and Winter; which they may be eaſily made ſo and not heavy: Which I believe moſt nice Men in Time-keeping will be willing to have ſuch when they conſult with Reaſon; ſo I ſhall leave that to the Conſideration of the Ingenious, which may ſatisfie themſelves by Experience, as I have done; and ſo give the Method to ſuit all Climates, which is this: Make a Screw on the End of the Pendulum Rod, that one Thread of it may be near 2 of an hundredth part of an Inch, that is about 55 Threads in an Inch; and the Ball being round like a Globe, ſcrew the Rod through the Center; having ſo many Threads in the Ball, it cannot riſe or fall unequal. Let the Ball be divided in the middle into 90 equal Parts, and numbred from 1 to 90; being figured at every 10; that when it is adjuſted true, the Pointer may cut the Number of the Latitude it is adjuſted at. Having a little Ball (as in *Fig.* 1.) to adjuſt it very exact, and then ſcrew the little Ball faſt: And when the Latitude is increaſed or decreaſed 10 or 20 deg. and your Courſe continuing the ſame Way for other 10 or 20 deg. turn it double the Number if they are like to ſail into that

Latitude where the Degrees of Heat is like to be doubled, as thus. A Ship bound for *Barbadoes*, and when they have decreaſed their Latitude 19 or 20 deg. having a Thermometer fix'd to the Machine, that it may not be annoyed by the Ship's Motion; but always keep perpendicular.

Obſerve the Degrees of Heat, and turn the Ball to the Degrees of Heat they are likely to meet with: As ſuppoſe the Sun have North Declination, ſo much that they muſt have it in their Zenith, turn 90 under the Pointer, and if it have South Declination, they may turn it to the Latitude of the Place; ſo by obſerving the Number of Days before and after their turning the Ball, and likewiſe the Degrees of Heat, they may have the true Time very near; ſeeing the greateſt Difference is but ſmall. So obſerving at their Return, to bring the Figures, for the Latitude they are bound to, that they find upon the Ball under the Pointer, when they have increaſed their Latitude about half of what they intend, that it may loſe that little that it had gained, and be fit for the Latitude when they come there: But there muſt be a due Reguard to the Number of Days before and after altering; and to the Degrees of Heat or Cold: So ſhall they have the true Time nearly given, in all Climates, for all Differences that is occaſioned by Heat or Cold.

If there be a Difference by Attraction, Experience will find it; and the Exceſs may be placed on the undivided Circle that is left for that Purpoſe on the Ball.

As for Ballances, if they come in hot Climates, their Radius, Diameter, and Circumference muſt certainly lengthen, and their Spiral Springs weaken; which will make much greater Variation than a Pendulum; For, if a Pendulum of four times the Length it was before, give half the Vibration it did: Take a Ballance of four times the Diameter it was, and it ſhall not give above one fourth of the Vibrations it did: So that the leaſt Alteration of the Radius in a Ballance, makes a greater Difference than three times as much in the ſame Proportion in a Pendulum.

Therefore, I hope the Ingenious will confeſs, there is no Motion invented that will keep ſo true Time as a Pendulum; when provided with ſuch Rods that bend not but at the Point of Suſpenſion.

And as a farther Proof of what hath been ſaid, I tried this Experiment with a Rod of Iron; to find what it lengthned in 41 Inches, at three different Degrees of Heat, (being aſſiſted by three of my ingenious Friends, *viz: Will. Tunſtall*, Gent.

John Newton, Mathem. and *James Reed*, Gunſmith.

After I had tried that before-mentioned with a Theromometer, and found it lengthen one hundredth part of an Inch, from the medium of Heat, to the hotteſt we could ſuppoſe to be in any Climate: Then I deſired their Aſſiſtance in this, that exceeded the Heat of all Climates upon Earth, which was thus.

The *Firſt* was boyling Liquor that lengthen'd it two hundredth Parts; the *Second* was a blew Heat, that lengthen'd it four hundredth Parts, and the *Third* was red-hot, which lengthen'd it twenty-four hundredth Parts of an Inch in the whole Rod, which was 41 Inches long; this is a true Account, according to the beſt of our Judgment.

Now, it plainly appears, that thoſe who concluded the Lengthening was ſuch as to make it uſeleſs in this Affair, was under a great Miſtake; for where Annimals can live, or Vegitables grow, it lengthens but about the four thouſand one hundredth Part of the whole Length of the Rod; and that in boyling Liquor, two thouſand and a fiftieth Part; a blew Heat one thouſand and a twenty fifth Part; and a red-hot a hundred and ſeventieth Part, of the

Length of the Rods here mentioned, And at the Heat of the three laſt, Animals cannot live, nor Vegitables grow; ſo that it is plain, the Difference that hath been ſo great, is occaſioned by the weakening of the Rod with the Heat, and ſtrengthning by Cold; for which there's a Remedy found, which makes their Difference very ſmall, which is before deſcribed, and the moſt ingenious Men have readily acknowledged upon mature Conſideration, that an Oval Pendulum-Rod, moving Edgeways, is the beſt fortified againſt Bending.

N. B. At every Sea-Port, where Ships touch in Long Voyages, there ought to be erected an Obſervatory, and a true Time-Piece kept in good Order; that the true Time of the Day or Night, (when they depart from any of theſe Ports) may be known: So this may diſcover the Difference of Meridian between any two Places with more Eaſe. The Charge of a good Time-Piece, and Telleſcope fixed with ſome other Inſtruments, is but ſmall, to the Advantage that may be reaped thereby.

So I humbly deſire the Honourable Commiſſioners appointed for the Diſcovery of the Longitude, to conſider and appoint a Day and Place where they will meet to put the Act in Execution, and give publick

lick Notice thereof; that thoſe who have made any Machines that may be of Service to the Diſcovery of the Longitude, may be examined by them, and give their Approbation according to Merit; that no ſerviceable Inſtrument, nor ingenious Propoſal may be loſt by Delay, nor forced to ſeek its Encouragement in Foreign Parts, and that the Service thereof go not to another Nation.

This is the humble Requeſt of him, who is willing to ſerve his King and Country, while

Jonah Crathorne.

Note, Here follow Tables of the *Sun's Declination* and *Right Aſcenſion*, for the Years of Our Lord, 1717, 1718, 1719, 1720.

A Table of the Sun's Declination, *for the Year* 1717, *being the First after* Leap-Year.

Days.	*Janua.* S.		*Febru.* S.		*March.* S*		*April* N.		*May.* N.		*June.* N.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21	38	13	37	3	15	8	35	18	10	23	11
2	21	27	13	17	2	51	9	07	18	25	23	15
3	21	17	12	57	2	27	9	29	18	40	23	18
4	21	06	12	36	2	03	9	40	18	54	23	21
5	20	55	12	15	1	40	10	11	19	07	23	23
6	20	43	11	54	1	16	10	32	19	22	23	25
7	20	31	11	33	0	52	11	53	19	35	23	27
8	20	18	11	12	0	29	11	14	19	48	23	28
9	20	05	10	51	0	5	11	34	20	01	23	29
10	19	52	10	29	N.	18	11	55	20	13	23	29
11	19	37	10	7	0	42	12	13	20	25	23	29
12	19	24	9	45	1	06	12	35	20	37	23	29
13	19	10	9	23	1	29	12	55	20	49	23	28
14	18	55	9	01	1	53	13	15	21	00	23	27
15	18	40	8	38	2	16	13	34	21	10	23	25
16	18	25	8	16	2	40	13	53	21	20	23	23
17	18	09	7	53	3	03	14	12	21	30	23	20
18	17	53	7	30	3	27	14	31	21	40	23	17
19	17	37	7	08	3	50	14	49	21	49	23	14
20	17	20	6	45	4	13	15	07	21	57	23	10
21	17	03	6	22	4	36	15	25	22	05	23	06
22	16	46	5	59	4	59	15	43	22	13	23	01
23	16	28	5	35	5	22	16	00	22	21	22	56
24	16	11	5	12	5	45	16	17	22	28	22	51
25	15	52	4	49	6	08	16	34	22	35	22	45
26	15	34	4	25	6	31	16	51	22	41	22	39
27	15	15	4	02	6	53	17	07	22	47	22	32
28	14	56	3	38	7	16	17	23	22	53	22	25
29	14	37			7	38	17	39	22	58	22	18
30	14	18			8	00	17	55	23	03	22	10
31	13	57			8	23			23	07		

A Table of the Sun's Declination, *for the Year* 1717, *being the Firſt after* Leap-Year.

Days.	*July.* N.		*Auguſt.* N.		*Septem.* N.*		*October.* S.		*Novem.* S.		*Decem.* S.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	22	02	15	01	4	11	7	27	17	47	23	08
2	21	53	14	43	3	48	7	50	18	03	23	12
3	21	44	14	25	3	25	8	12	18	19	23	16
4	21	35	14	06	3	02	8	35	18	34	23	20
5	21	25	13	47	2	39	8	57	18	49	23	22
6	21	15	13	28	2	16	9	19	19	04	23	24
7	21	04	13	05	1	53	9	41	19	19	23	26
8	20	53	12	49	1	30	10	03	19	33	23	28
9	20	42	12	29	1	06	10	25	19	47	23	29
10	20	31	12	09	0	42	10	46	20	00	23	29
11	20	19	11	49	0	18	11	08	20	13	23	29
12	20	07	11	29	S.	05	11	29	20	26	23	29
13	19	55	11	08	0	29	11	50	20	38	23	27
14	19	42	10	47	0	53	12	11	20	50	23	26
15	19	29	10	26	1	16	12	31	21	02	23	24
16	19	16	10	05	1	40	12	51	21	13	23	22
17	19	03	9	44	2	03	13	11	21	23	23	19
18	18	49	9	23	2	27	13	31	21	34	23	16
19	18	34	9	02	2	50	13	41	21	44	23	12
20	18	19	8	40	3	14	14	11	21	53	23	08
21	18	04	8	18	3	38	14	30	22	02	23	03
22	17	49	7	56	4	00	14	49	22	11	22	58
23	17	33	7	34	4	24	15	08	22	19	22	52
24	17	17	7	12	4	47	15	27	22	27	22	46
25	17	01	6	50	5	10	15	45	22	35	22	39
26	16	45	6	28	5	33	15	03	22	41	22	32
27	16	28	6	06	5	56	15	21	22	47	22	25
28	16	11	5	43	6	19	16	39	22	53	22	17
29	15	54	5	20	6	42	16	56	22	58	22	09
30	15	37	4	57	7	05	17	13	23	03	21	59
31	15	19	4	34			17	30			21	50

A Table of the Sun's Declination, *for the Year* 1718; *being the Second after* Leap-Year.

Days.	*Janua.* S.		*Febru.* S.		*March* S *		*April* N.		*May.* N.		*June.* N.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21	40	13	42	3	20	8	39	18	07	23	10
2	21	30	13	22	2	57	9	01	18	22	23	14
3	21	20	13	02	2	33	9	23	18	36	23	17
4	21	9	12	41	2	09	9	44	18	51	23	20
5	20	58	12	20	1	46	10	05	19	05	23	23
6	20	46	11	59	1	22	10	27	19	19	23	25
7	20	34	11	38	0	58	10	48	19	32	23	26
8	20	21	11	17	0	35	11	09	19	45	23	28
9	20	09	10	56	0	11	11	29	19	58	23	29
10	19	55	10	34	N	12	11	50	20	11	23	29
11	19	42	10	12	0A	36	12	10	20	23	23	29
12	19	29	9	50	1	00	12	30	20	34	23	29
13	19	14	9	28	1	23	12	50	20	46	23	28
14	19	00	9	06	1	47	13	10	20	57	23	27
15	18	44	8	44	2	10	13	29	21	08	23	25
16	18	29	8	21	2	34	13	44	21	18	23	23
17	18	13	7	59	2	57	14	08	21	28	23	21
18	17	57	7	36	3	20	14	26	21	37	23	18
19	17	41	7	13	3	44	14	45	21	46	23	14
20	17	24	6	50	4	07	15	02	21	54	23	11
21	17	07	6	27	4	31	15	20	22	03	23	07
22	16	50	6	04	4	54	15	38	22	11	23	02
23	16	38	5	41	5	17	15	56	22	19	22	57
24	16	15	5	18	5	40	16	13	22	25	22	52
25	15	57	4	55	6	03	16	20	22	33	22	46
26	15	39	4	31	6	25	16	47	22	40	22	40
27	15	20	4	07	6	48	17	03	22	46	22	34
28	15	01	3	44	7	10	17	20	22	51	22	28
29	14	42			7	33	17	36	22	57	22	21
30	14	22			7	55	17	51	23	02	22	13
31	14	03			8	17			23	05		

A Table of the Sun's Declination, *for the Year* 1718, *being the Second after* Leap-Year.

Days.	*July.* N.		*Auguſt.* N.		*Septem.* N.*		*October.* S.		*Novem.* S.		*Decem* S.	
	D.	M.	D.	M.	D,	M.	D.	M.	D.	M.	D.	M.
1	22	05	15	05	4	17	7	22	17	43	23	07
2	21	56	14	47	3	54	7	44	17	59	23	11
3	21	47	14	29	3	31	8	07	18	15	23	15
4	21	38	14	10	3	08	8	29	18	30	23	19
5	21	29	13	51	2	44	8	52	18	46	23	22
6	21	19	13	32	2	20	9	14	19	00	23	24
7	21	09	13	13	1	57	9	36	19	15	23	26
8	20	58	12	53	1	33	9	58	19	29	23	28
9	20	47	12	34	1	10	10	20	19	43	23	28
10	20	35	12	14	0	46	10	42	19	57	23	29
11	20	23	11	54	0	23	11	03	20	10	23	29
12	20	11	11	34	0	00	11	24	20	23	23	29
13	19	58	11	13	S.	24	11	45	20	35	23	28
14	19	45	10	52	0	47	12	05	20	47	23	27
15	19	32	10	32	1	11	12	26	20	59	23	25
16	19	19	10	11	1	34	12	46	21	10	23	22
17	19	05	9	50	1	58	13	06	21	21	23	19
18	18	51	9	28	2	21	13	26	21	31	23	16
19	18	37	9	07	2	44	13	46	21	41	23	12
20	18	22	8	45	3	08	14	06	21	51	23	09
21	18	07	8	24	3	31	14	25	22	00	23	04
22	17	52	8	02	3	55	14	45	22	09	22	59
23	17	37	7	48	4	18	15	04	22	17	22	53
24	17	21	7	18	4	41	15	22	22	25	22	47
25	17	05	6	56	5	04	15	41	22	33	22	41
26	16	49	6	34	5	27	15	59	22	39	22	34
27	16	32	6	12	5	50	16	17	22	45	22	26
28	16	15	5	49	6	13	16	35	22	52	22	28
29	15	58	5	26	6	36	16	16	22	57	22	10
30	15	41	5	03	6	59	17	09	23	02	22	01
31	15	23	4	40			17	26			21	52

A Table of the Sun's Declination, *for the Year* 1719, *being the Third after* Leap-Year.

Days.	*Janua.*		*Feb.*		*March.*		*April.*		*May.*		*June.*	
	S.		S.		S. *		N.		N.		N.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21	42	13	47	3	26	8	34	18	03	23	09
2	21	32	13	27	3	02	8	56	18	18	23	13
3	21	22	13	07	2	39	9	17	18	33	23	17
4	21	11	12	46	2	15	9	39	18	47	23	20
5	21	00	12	25	1	52	10	00	19	02	23	22
6	20	49	12	04	1	28	10	22	19	15	23	24
7	20	37	11	44	1	04	10	43	19	29	23	26
8	20	24	11	22	0	41	11	04	19	42	23	27
9	20	12	11	01	0	17	11	24	19	55	23	28
10	19	59	10	39	N.	06	11	45	20	07	23	29
11	19	45	10	18	0	30	12	05	20	19	23	29
12	19	31	9	56	0	54	12	25	20	31	23	29
13	19	17	9	34	1	18	12	45	20	43	23	28
14	19	03	9	12	1	41	13	05	20	54	23	27
15	18	48	8	49	2	05	13	25	21	05	23	25
16	18	32	8	27	2	28	13	44	21	15	23	23
17	18	17	8	04	2	52	14	03	21	25	23	21
18	18	01	7	42	3	15	14	22	21	35	23	18
19	17	45	7	19	3	38	14	41	21	44	23	15
20	17	28	6	56	4	02	14	59	21	52	23	12
21	17	11	6	33	4	25	15	16	22	01	23	08
22	16	54	6	10	4	48	15	34	22	09	23	03
23	16	37	5	47	5	11	15	52	22	17	22	58
24	16	19	5	23	5	34	16	09	22	24	22	53
25	16	01	4	00	5	57	16	26	22	31	22	48
26	15	43	4	37	6	20	16	43	22	38	22	42
27	15	24	4	13	6	42	16	59	22	44	22	35
28	15	06	3	50	7	05	17	16	22	50	22	27
29	14	47			7	27	17	32	22	55	22	21
30	14	27			7	50	17	47	23	00	22	13
31	14	07			8	12			23	05		

A Table of the Sun's Declination, *for the Year* 1719, *being the Third after* Leap-Year.

Days.	*July.*		*Auguſt.*		*Septem.*		*October.*		*Novem.*		*Decem.*	
	N.		N.		N. *		S.		S.		S.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	22	04	15	10	4	23	7	16	17	39	23	06
2	21	56	14	52	4	00	7	39	17	55	23	10
3	21	38	14	33	3	56	8	02	18	11	23	14
4	21	39	14	15	3	13	8	24	18	27	23	18
5	21	29	13	56	2	50	8	46	18	42	23	21
6	22	19	13	37	2	26	9	08	18	57	23	23
7	22	09	13	18	2	02	9	29	19	12	23	25
8	22	00	12	58	1	39	9	51	19	26	23	27
9	20	48	12	39	1	16	10	11	19	40	23	28
10	20	37	12	19	0	52	10	35	19	53	23	29
11	20	25	12	00	0	29	10	56	20	07	23	29
12	20	13	11	39	0	05	11	18	20	20	23	29
13	20	01	11	18	S.	18	11	39	20	32	23	28
14	19	48	10	58	0	41	12	00	20	44	23	27
15	19	35	10	37	1	05	12	20	20	56	23	25
16	19	22	10	16	1	28	12	41	21	07	23	23
17	19	08	9	55	1	52	13	01	21	18	23	20
18	18	56	9	34	2	15	13	22	21	29	23	17
19	18	40	9	12	2	39	13	41	21	39	23	14
20	18	26	8	51	3	02	14	01	21	49	23	10
21	18	11	8	29	3	26	14	21	21	58	23	05
22	17	56	8	07	3	49	14	40	22	07	23	00
23	17	41	7	45	4	12	14	59	22	15	22	55
24	17	25	7	23	4	35	15	18	22	23	22	49
25	17	09	7	01	4	59	15	36	22	30	22	43
26	16	53	6	39	5	22	15	55	22	37	22	36
27	16	36	6	16	5	45	16	13	22	44	22	28
28	16	19	5	54	6	08	16	30	22	50	22	20
29	16	02	5	31	6	31	16	48	22	56	22	12
30	15	45	5	08	6	54	17	05	23	01	22	03
31	15	27	4	45			17	22			21	55

A Table of the Sun's Declination, *for the Year* 1720, *being* Leap-Year.

Days.	*Janua.*		*Februa.*		*March.*		*April.*		*May.*		*June.*	
	S.		S.		S. *		N.		N.		N.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21	45	13	52	3	08	8	50	18	14	23	12
2	21	35	13	32	2	45	9	12	18	29	23	16
3	21	25	13	12	2	21	9	34	18	44	23	19
4	21	14	12	51	1	57	9	55	18	58	23	22
5	21	03	12	31	1	34	10	16	19	12	23	24
6	20	52	12	10	1	10	10	37	19	25	23	26
7	20	40	11	49	0	46	10	58	19	39	23	27
8	20	28	11	28	0	23	11	19	19	52	23	28
9	20	15	11	06	0	00	11	40	20	04	23	29
10	20	02	10	45	N.	24	12	00	20	17	23	29
11	19	49	10	23	0	48	12	21	20	29	23	29
12	19	35	10	01	1	12	12	40	20	40	23	28
13	19	21	9	39	1	36	13	00	20	51	23	27
14	19	06	9	17	1	59	13	20	21	02	23	26
15	18	51	8	55	2	23	13	39	21	13	23	24
16	18	36	8	32	2	46	13	58	21	23	23	22
17	18	20	8	10	3	10	14	17	21	33	23	19
18	18	05	7	47	3	33	14	36	21	42	23	16
19	17	40	7	24	3	56	14	54	21	51	23	12
20	17	33	7	01	4	19	15	12	21	59	23	09
21	17	16	6	38	4	43	15	29	22	07	23	04
22	16	59	6	15	5	06	15	47	22	15	23	59
23	16	41	5	52	5	29	16	05	22	23	22	54
24	16	24	5	29	5	51	16	22	22	30	22	49
25	16	06	5	06	6	14	16	39	22	36	22	43
26	15	47	4	42	6	37	16	55	22	43	22	37
27	15	29	4	19	6	59	17	12	22	49	22	30
28	15	10	3	55	7	22	17	28	22	54	22	23
29	14	51	3	32	7	44	17	44	22	58	22	15
30	14	31			8	06	17	59	23	04	22	07
31	14	11			8	28			23	08		

A Table of the Sun's Declination, *for the Year* 1720, *being* Leap-Year.

Days.	*July.*		*August.*		*Septem.*		*October.*		*Novem.*		*Decem.*	
	N.		N.		N. *		S.		S.		S.	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	21	58	14	55	4	04	7	34	17	51	23	09
2	21	50	14	37	3	41	7	56	18	07	23	13
3	21	41	14	18	3	18	8	18	18	23	23	17
4	21	31	14	00	2	55	8	40	18	38	23	20
5	21	20	13	40	2	32	9	02	18	53	23	23
6	21	12	13	21	2	00	9	24	19	08	23	25
7	21	01	13	02	1	45	9	46	19	23	23	26
8	20	50	12	42	1	21	10	08	19	37	23	28
9	20	39	12	22	0	58	10	30	19	50	23	29
10	20	28	12	02	0	34	10	51	20	03	23	29
11	20	16	11	42	0	11	11	12	20	16	23	29
12	20	04	11	22	S.	12	11	43	20	29	23	28
13	19	52	11	02	0	36	11	54	20	41	23	27
14	19	38	10	41	0	59	12	15	20	53	23	26
15	19	25	10	20	1	23	12	36	21	05	23	24
16	19	12	10	00	1	46	12	56	21	16	23	21
17	18	58	9	38	2	10	13	16	21	26	23	18
18	18	44	9	16	2	33	13	36	21	36	23	15
19	18	29	8	55	2	57	13	56	21	46	23	11
20	18	15	8	33	3	20	14	16	21	55	23	06
21	18	00	8	11	3	43	14	35	22	04	23	01
22	17	44	7	50	4	07	14	55	22	13	22	56
23	17	29	7	27	4	30	15	14	22	21	22	50
24	17	13	7	05	4	53	15	33	22	29	22	44
25	16	57	6	43	5	16	15	51	22	36	22	37
26	16	40	6	21	5	39	16	09	22	42	22	30
27	16	23	6	00	6	02	16	26	22	48	22	23
28	16	06	5	35	6	25	16	43	22	54	22	15
29	15	48	5	13	6	48	17	00	23	00	22	06
30	15	31	4	50	7	11	17	17	23	05	21	57
31	15	13	4	27			17	14			21	48

A Table of the Sun's Right Aſcenſion, *in Hours and Minutes, for the Year* 1717, *being the Firſt after* Leap-Year.

Days	*Janua.*		*Febru.*		*March.*		*April.*		*May.*		*June.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	19	36	21	44	23	29	1	22	3	16	5	21
2	19	40	21	48	23	33	1	25	3	20	5	25
3	19	44	21	52	23	36	1	29	3	24	5	29
4	19	49	21	56	23	40	1	33	3	27	5	33
5	19	53	22	00	23	44	1	37	3	31	5	37
6	19	57	22	04	23	48	1	40	3	35	5	42
7	20	01	22	07	23	51	1	44	3	39	5	46
8	20	05	22	11	23	54	1	48	3	43	5	50
9	20	09	22	15	23	58	1	51	3	47	5	54
10	20	14	22	18	00	02	1	56	3	51	5	58
11	20	18	22	22	00	05	1	59	3	55	6	03
12	20	22	22	26	0	09	2	02	3	59	6	07
13	20	27	22	30	0	13	2	06	4	03	6	11
14	20	31	22	34	0	16	2	10	4	07	6	15
15	20	35	22	38	0	20	2	14	4	11	6	19
16	20	39	22	41	0	24	2	17	4	15	6	23
17	20	44	22	45	0	27	2	21	4	19	6	28
18	20	48	22	49	0	31	2	25	4	23	6	32
19	20	52	22	53	0	34	2	30	4	28	6	36
20	20	56	22	56	0	38	2	33	4	32	6	40
21	21	00	23	00	0	42	2	36	4	36	6	44
22	21	04	23	04	0	45	2	40	4	40	6	48
23	21	08	23	08	0	49	2	44	4	44	6	52
24	21	12	23	11	0	53	2	48	4	48	6	56
25	21	16	23	15	0	56	2	53	4	53	7	00
26	21	20	23	18	1	00	2	56	5	56	7	05
27	21	24	23	22	1	03	2	59	5	00	7	09
28	21	28	23	26	1	07	3	03	5	04	7	13
29	21	32			1	11	3	07	5	09	7	17
30	21	35			1	15	3	11	5	13	7	21
31	21	40			1	18			5	17		

A Table of the Sun's Right Aſcenſion *in Hours and Minutes, for the Year* 1717, *being the Firſt after* Leap-Year.

Days	*July.*		*Auguſt.*		*Septem.*		*October.*		*Novem.*		*Decem.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	7	25	9	27	11	20	13	10	15	10	17	18
2	7	29	9	31	11	24	13	13	15	14	17	22
3	7	33	9	35	11	28	13	17	15	18	17	26
4	7	38	9	38	11	32	13	21	15	22	17	31
5	7	42	9	42	11	35	13	25	15	26	17	35
6	7	46	9	46	11	39	13	28	15	30	17	40
7	7	49	[illegible]	50	11	42	13	32	15	34	17	44
8	7	54	9	54	11	46	13	36	15	38	17	45
9	7	58	9	57	11	50	13	40	15	43	17	53
10	8	01	10	01	11	53	13	43	15	47	17	58
11	8	06	10	04	11	57	13	47	15	51	18	02
12	8	10	10	08	12	01	13	50	15	55	18	07
13	8	14	10	11	12	04	13	54	16	00	18	11
14	8	18	10	15	12	08	13	58	16	04	18	16
15	8	21	10	19	12	12	14	02	16	08	18	20
16	8	25	10	22	12	15	14	06	16	13	18	24
17	8	29	10	26	12	18	14	10	16	17	18	29
18	8	33	10	30	12	22	14	14	16	21	18	33
19	8	37	10	33	12	26	14	10	16	25	18	38
20	8	41	10	37	12	29	14	22	16	30	18	42
21	8	45	10	41	12	32	14	26	16	34	18	46
22	8	49	10	44	12	36	14	30	16	39	18	51
23	8	53	10	47	12	40	14	34	16	43	18	55
24	8	56	10	51	12	43	14	38	16	47	19	00
25	9	00	10	55	12	47	14	42	16	52	19	04
26	9	04	10	58	12	51	14	46	16	56	19	09
27	9	08	11	02	12	54	14	50	17	00	19	13
28	9	12	11	06	12	58	14	54	17	04	19	17
29	9	16	11	09	13	02	14	58	17	09	19	21
30	9	20	11	13	13	06	15	02	17	13	19	26
31	9	24	11	16			15	06			19	30

A Table of the Sun's Right Aſcenſion *in Hours and Minutes, for the Year* 1718. *being the Second after* Leap-Year.

Days	*Janua.*		*Febru.*		*March*		*April*		*May.*		*June.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	19	35	21	43	23	29	1	21	3	14	5	20
2	19	39	21	47	23	32	1	24	3	18	5	24
3	19	43	21	51	23	36	1	28	3	22	5	28
4	19	48	21	55	23	40	1	32	3	26	5	32
5	19	52	21	59	23	43	1	36	3	30	5	36
6	19	56	22	03	23	47	1	39	3	34	5	41
7	20	00	22	06	23	51	1	43	3	38	5	45
8	20	04	22	10	23	54	1	47	3	42	5	49
9	20	08	22	14	23	58	1	51	3	46	5	53
10	20	13	22	18	0	01	1	55	3	50	5	57
11	20	17	22	21	0	04	1	58	3	54	6	02
12	20	21	22	25	0	08	2	01	3	58	6	06
13	20	26	22	29	0	12	2	05	4	02	6	10
14	20	30	22	33	0	15	2	09	4	06	6	14
15	20	34	22	37	0	20	2	13	4	10	6	18
16	20	38	22	40	0	23	2	16	4	14	6	22
17	20	43	22	44	0	26	2	20	4	18	5	27
18	20	47	22	48	0	30	2	24	4	22	6	31
19	20	53	22	52	0	34	2	28	4	27	6	35
20	20	55	22	55	0	38	2	32	4	31	6	39
21	20	59	22	59	0	41	2	35	4	35	6	43
22	21	03	23	03	0	44	2	39	4	39	6	47
23	21	07	23	07	0	48	2	43	4	43	6	51
24	21	11	23	10	0	52	2	47	4	47	6	55
25	21	15	23	14	0	55	2	51	4	51	6	59
26	21	19	23	18	0	59	2	55	4	55	7	04
27	21	23	23	21	1	02	2	58	4	59	7	08
28	21	27	23	25	1	06	3	02	5	03	7	12
29	21	31			1	10	3	06	5	08	7	16
30	21	35			1	14	3	10	5	12	7	20
31	21	39			1	14			5	16		

A Table of the Sun's Right Aſcenſion in Hours and Minutes, for the Year 1718, being the Second after Leap-Year.

Days	July.		Auguſt.		Septem.		October.		Novem.		Decem.	
d.	H.	M	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	7	24	9	26	11	20	13	09	15	09	17	17
2	7	28	9	30	11	23	13	12	15	13	17	21
3	7	32	9	34	11	27	13	16	15	17	17	25
4	7	36	9	37	11	31	13	20	15	21	17	30
5	7	40	9	41	11	34	13	24	25	25	17	34
6	7	44	9	45	11	38	13	27	15	29	17	39
7	7	48	9	49	11	41	13	31	15	33	17	43
8	7	52	9	53	11	45	13	35	15	37	17	48
9	7	56	9	56	11	49	13	39	15	42	17	52
10	8	01	10	00	11	53	13	42	15	46	17	57
11	8	05	10	04	11	56	13	46	15	50	18	01
12	8	09	10	07	12	00	13	50	15	54	18	05
13	8	13	10	11	12	03	13	54	15	59	18	10
14	8	17	10	15	12	07	13	58	16	03	18	14
15	8	21	10	18	12	11	14	01	16	07	18	19
16	8	25	10	22	12	14	14	05	16	11	18	23
17	8	29	10	26	12	18	14	09	16	16	18	27
18	8	33	10	29	12	21	14	13	16	20	18	32
19	8	36	10	33	12	24	14	17	16	24	18	36
20	8	40	10	37	12	28	14	21	16	29	18	41
21	8	44	10	40	12	31	14	25	16	33	18	45
22	8	48	10	44	12	35	14	29	16	37	18	50
23	8	52	10	47	12	39	14	33	16	42	18	54
24	8	55	10	50	12	43	14	37	16	46	18	58
25	8	59	10	55	12	47	14	41	16	50	19	03
26	9	03	11	58	12	50	14	45	16	54	19	07
27	9	07	11	01	12	54	14	49	16	59	19	12
28	9	11	11	06	12	58	14	53	17	03	19	16
29	9	15	11	09	13	01	14	57	17	08	19	20
30	9	18	11	13	13	05	15	01	17	12	19	25
31	9	22	11	16			15	05			19	29

A Table of the Sun's Right Aſcenſion *in Hours and Minutes, for the Year* 1719, *being the Third after* Leap-Year.

Days	*Janua.*		*Febru.*		*March*		*April*		*May.*		*June.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	19	34	21	42	23	28	1	21	3	14	5	19
2	19	38	21	46	23	31	1	24	3	18	5	23
3	19	42	21	50	23	35	1	28	3	22	5	27
4	19	47	21	54	23	39	1	31	3	25	5	31
5	19	51	21	58	23	42	1	35	3	29	5	35
6	19	55	22	02	23	46	1	39	3	33	5	40
7	19	59	22	05	23	50	1	43	3	37	5	44
8	20	03	22	09	23	53	1	46	3	41	5	48
9	20	07	22	13	23	57	1	50	3	45	5	52
10	20	12	22	17	00	01	1	54	3	49	5	56
11	20	16	22	20	0	04	1	57	3	53	6	01
12	20	20	22	24	0	08	2	01	3	57	6	05
13	20	25	22	28	0	11	2	05	4	01	6	09
14	20	29	22	32	0	15	2	09	4	05	6	13
15	20	33	22	36	0	19	2	12	4	09	6	17
16	20	37	22	39	0	22	2	16	4	13	6	21
17	20	42	22	43	0	26	2	20	4	17	6	26
18	20	46	22	47	0	29	2	24	4	21	6	30
19	20	50	22	51	0	33	2	28	4	26	6	34
20	20	54	22	54	0	37	2	32	4	30	6	38
21	20	58	22	58	0	40	2	35	4	34	6	42
22	21	02	23	02	1	44	2	39	4	38	6	46
23	21	06	23	06	1	48	2	43	4	42	6	50
24	21	10	23	09	1	51	2	47	4	46	6	54
25	21	14	23	13	1	55	2	51	4	50	6	58
26	21	18	23	17	1	59	2	54	4	54	7	03
27	21	22	23	20	1	02	2	58	4	58	7	07
28	21	26	23	24	1	06	3	02	5	02	7	11
29	21	30			1	10	3	06	5	07	7	15
30	21	34			1	13	3	10	5	11	7	19
31	21	38			1	17			5	15		

A Table of the Sun's Right Aſcenſion *in Hours and Minutes, for the Year* 1719, *being the Third after* Leap-Year.

Days	*July.*		*Auguſt.*		*Septem.*		*October.*		*Novem.*		*Decem.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	7	23	9	25	11	19	13	08	15	08	17	16
2	7	27	9	29	11	22	13	11	15	12	17	20
3	7	31	9	33	11	26	13	15	15	16	17	24
4	7	35	9	36	11	30	13	19	15	20	17	29
5	7	39	9	40	11	33	13	23	15	24	17	33
6	7	43	9	44	11	37	13	26	15	28	17	38
7	7	47	9	48	11	40	13	30	15	32	17	42
8	7	51	9	52	11	44	13	34	15	36	17	47
9	7	55	9	55	11	48	13	38	15	41	17	51
10	7	59	9	59	11	51	13	41	15	45	17	55
11	8	03	10	03	11	55	13	45	15	49	18	00
12	8	07	10	06	11	59	13	49	15	53	18	04
13	8	11	10	10	12	02	13	53	15	58	18	09
14	8	15	10	14	12	06	13	57	16	02	18	14
15	8	19	10	17	12	10	14	00	16	06	18	18
16	8	23	10	21	12	13	14	04	16	10	18	22
17	8	27	10	25	12	17	14	08	16	15	18	26
18	8	31	10	28	12	20	14	12	16	19	18	31
19	8	35	10	32	12	24	14	16	16	23	18	35
20	8	39	10	36	12	28	14	20	16	27	18	40
21	8	43	10	39	12	31	14	24	16	32	18	44
22	8	47	10	43	12	35	14	28	16	36	18	49
23	8	51	10	46	12	38	14	32	16	41	18	53
24	8	54	10	50	12	42	14	36	16	45	18	57
25	8	58	10	54	12	46	14	40	16	49	19	02
26	9	02	10	57	12	49	14	44	16	53	19	06
27	9	06	11	01	12	53	14	48	16	58	19	11
28	9	10	11	05	12	57	14	52	16	02	19	19
29	9	14	11	08	13	00	14	56	17	07	19	15
30	9	18	11	12	13	04	15	00	17	11	19	24
31	9	21	11	15			15	04			19	28

A Table of the Sun's Right Aſcenſion, *in Hours and Minutes, for the Year* 1720, *being* Leap-Year.

Days	*Janua.*		*Febru.*		*March.*		*April.*		*May.*		*June.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	19	33	21	41	23	30	1	23	3	17	5	22
2	19	37	21	45	23	34	1	26	3	21	5	26
3	19	41	21	49	23	37	1	30	3	25	5	30
4	19	46	21	53	23	41	1	34	3	28	5	34
5	19	50	21	57	23	45	1	38	3	32	5	38
6	19	54	22	01	23	49	1	41	3	36	5	43
7	19	58	22	04	23	52	1	45	3	40	5	47
8	20	02	22	09	23	55	1	49	3	44	5	51
9	20	06	22	13	23	59	1	53	3	48	5	55
10	20	11	22	16	0	03	1	57	3	52	6	00
11	20	15	22	20	0	06	2	00	3	56	6	04
12	20	19	22	24	0	10	2	03	4	00	6	08
13	20	24	22	27	0	14	2	07	4	04	6	12
14	20	28	22	31	0	18	2	11	4	08	6	16
15	20	32	22	35	0	22	2	15	4	12	6	21
16	20	36	22	38	0	25	2	18	4	16	6	25
17	20	41	22	42	0	28	2	22	4	20	6	29
18	20	45	22	46	0	32	2	26	4	24	6	33
19	20	49	22	50	0	35	2	31	4	29	6	37
20	20	53	22	53	0	39	2	34	4	33	6	41
21	20	57	22	57	0	44	2	37	4	37	6	46
22	21	01	23	01	0	46	2	41	4	41	6	50
23	21	05	23	05	0	50	2	45	4	45	6	54
24	21	09	23	08	0	54	2	49	4	49	6	57
25	21	13	23	12	0	57	2	54	4	53	7	02
26	21	17	23	16	1	01	3	57	4	57	7	06
27	21	21	23	19	1	04	3	00	5	01	7	10
28	21	25	23	23	1	08	3	04	5	05	7	14
29	21	29	23	27	1	12	3	08	5	10	7	18
30	21	33			1	16	3	13	5	14	7	22
31	21	37			1	19			5	18		

A Table of the Sun's Right Aſcenſion *in Hours and Minutes, for the Year* 1720, *being* Leap-Year.

Days	*July.*		*Auguſt.*		*Soptem.*		*October.*		*Novem.*		*Decem.*	
d.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	7	26	9	28	11	21	13	11	15	11	17	19
2	7	30	9	32	11	24	13	15	15	15	17	23
3	7	34	9	36	11	28	13	18	15	19	17	27
4	7	39	9	39	11	32	13	22	15	23	17	32
5	7	43	9	43	11	36	13	26	15	27	17	36
6	7	47	9	47	11	39	13	29	15	31	17	41
7	7	50	9	51	11	43	13	33	15	35	17	45
8	7	54	6	55	11	46	13	37	15	39	17	50
9	7	58	9	58	11	50	13	41	15	44	17	54
10	8	02	10	02	11	54	13	44	15	48	17	59
11	8	06	10	06	11	57	13	48	15	52	18	03
12	8	10	10	09	12	01	13	52	15	56	18	07
13	8	14	10	13	12	05	13	56	16	01	18	12
14	8	18	10	17	12	08	14	00	16	05	18	17
15	8	22	10	20	12	12	14	03	16	09	18	21
16	8	26	10	24	12	16	14	07	16	13	18	25
17	8	30	10	28	12	19	14	11	16	18	18	30
18	8	34	10	31	12	23	14	15	16	22	18	34
19	8	38	10	35	12	26	14	19	16	26	18	39
20	8	42	10	38	12	30	14	23	16	31	18	43
21	8	46	10	42	12	33	14	27	16	35	18	47
22	8	50	10	45	12	37	14	31	16	40	18	52
23	8	54	10	49	12	41	14	35	16	44	18	56
24	8	57	10	52	12	44	14	39	16	48	19	00
25	9	01	10	56	12	48	14	43	16	53	19	05
26	9	05	11	00	12	52	14	47	16	56	19	10
27	9	09	11	03	12	55	14	51	17	01	19	14
28	9	13	11	07	12	59	14	55	17	05	19	18
29	9	17	11	[illegible]	13	03	14	59	17	10	19	23
30	9	20	11	14	13	07	15	03	17	14	19	27
31	9	24	11	17			15	07			19	31

The Explanation of the following Table.

Where the Word *Add* is, add to the apparent Time, until it come at this Mark *; and then it is ſubtract from the apparent Time, to the next *.

A New Correct Table for equating of Natural Days.

Days.	*Janua.* M.	Sec.	*Feb.* M.	Sec.	*March.* M.	Sec.	*April.* M.	Sec.	*May.* M.	Sec.	*June.* M.	Sec.
1	9	2	14	50	10	07	0	44	4	11	1	00
2	9	26	14	49	9	49	0	28	4	12	0	48
3	9	49	14	47	9	31	0	12	4	12	0	36
4	10	11	14	43	9	13	0 *	00	4	13	0	23
5	10	31	14	38	8	55	0	16	4	13	0	10
6	10	51	14	33	8	37	0	32	4	13	0 *	03
7	11	10	14	28	8	19	0	48	4	12	0	16
8	11	Add 29	14	Add 22	8	Add 01	1	Subtract 02	4	Subtract 11	0	Add 29
9	11	47	14	16	7	43	1	16	4	08	0	42
10	12	03	14	09	7	25	1	30	4	04	0	55
11	12	18	14	01	7	06	1	43	4	00	1	08
12	12	33	13	52	6	47	1	55	3	56	1	21
13	12	47	13	43	6	28	2	07	3	51	1	34
14	13	01	13	33	6	09	2	18	3	46	1	47
15	13	14	13	22	5	50	2	29	3	41	1	59
16	13	27	13	10	5	31	2	39	3	35	2	12
17	13	39	12	58	5	12	2	49	3	28	2	24
18	13	50	12	46	4	53	2	Suqtract 58	3	21	2	36
19	14	00	12	34	4	35	3	07	3	13	2	48
20	14	08	12	22	4	17	3	15	3	05	3	00
21	14	15	12	09	3	58	3	23	2	56	3	12
22	14	22	11	56	3	39	3	31	2	47	3	24
23	14	Add 28	11	Add 42	3	Add 20	3	38	2	Subtract 38	3	Add 35
24	14	34	11	27	3	01	3	44	2	29	3	46
25	14	39	11	11	2	43	3	50	2	19	3	56
26	14	43	10	56	2	25	3	55	2	08	4	06
27	14	46	10	40	2	07	3	59	1	57	4	16
28	14	48	10	24	1	50	4	03	1	46	4	25
29	14	49			1	33	4	06	1	34	4	34
30	14	50			1	16	4	09	1	23	4	43
31	14	51			1	00	4	[illegible]	1	12		

This Table was calculated for the Second Year after Leap-Year.

Note, Add ſhews Clock too faſt, and *Subtract* Clock too ſlow.

A New Correct Table for equating of Natural Days.

Days.	*July.*		*August.*		*Septem.*		*October.*		*Novem.*		*Decem.*	
	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.	M.	Sec.
1	4	52	4	35	3	50	13	26	15	25	5	48
2	5	00	4	25	4	12	13	29	15	16	5	18
3	5	08	4	15	4	33	13	51	15	07	4	48
4	5	14	4	04	4	54	14	02	14	58	4	18
5	5	19	3	52	5	15	14	13	14	48	3	48
6	5	24	3	40	5	36	14	24	14	37	3	18
7	5	29	3	27	5	56	14	35	14	24	2	48
8	5 Add	34	3 Add	14	6 Subtract	16	14 Subtract	46	14 Subtract	10	2 Subtract	18
9	5	38	3	01	6	36	14	57	13	55	1	48
10	5	42	2	47	6	56	15	08	13	39	1	18
11	5	46	2	33	7	17	15	18	13	23	0	48
12	5	49	2	18	7	38	15	27	13	07	0	18
13	5	51	2	03	7	59	15	34	12	50	0 *	13
14	5	52	1	47	8	20	15	40	12	32	0	43
15	5	53	1	31	8	41	15	46	12	14	1	13
16	5	53	1	15	9	01	15	51	11	55	1	43
17	5	52	0	58	9	21	15	55	11	34	2	13
18	5	51	0	41	9	41	15	58	11	12	2	43
19	5	49	0	24	10	00	16	01	10	50	3	13
20	5	47	0 *	06	10	19	16	03	10	27	3	43
21	5	44	0	13	10	38	16	04	10	03	4	12
22	5	41	0	32	10	56	16	05	9	39	4	41
23	5 Add	37	0 Subtract	51	11 Subtract	13	16 Subtract	06	9 Subtract	14	5 Add	9
24	5	33	1	10	11	30	16	05	8	49	5	37
25	5	28	1	29	11	47	16	04	8	24	6	03
26	5	23	1	49	12	03	16	04	7	59	6	29
27	5	17	2	09	12	21	16	01	7	34	6	55
28	5	10	2	29	12	38	15	57	7	09	7	21
29	5	02	2	49	12	56	15	50	6	43	7	46
30	4	53	3	49	13	11	15	43	6	17	8	10
31	4	44	3	29			15	34			8	34

A Table ſhewing the Right Aſcenſion, an Declination of Thirty One Eminent Fixe Stars.

Stars Names.	Right Aſcen. H.	Right Aſcen. M.	Declination D.	Declination M.	N or S
The Knot of the String of the Fiſhes.	1	47	1	20	N
The Bright Star of Aries.	1	51	22	4	N
The Jaw of the Whale.	2	47	2	46	N
Arcturus	14	02	20	44	N
The Lyon's Tail.	11	34	16	12	N
The Virgin's Spike.	13	10	9	37	S
The Head of the Northern Twins.	7	15	32	29	N
The Right Shoulder of Orion.	5	39	7	19	N
The Left Shoulder of Orion.	5	10	6	3	N
The Dog-Star Syrius.	6	32	16	20	S
The Leſſer Dog-Star.	7	24	5	57	N
The Bright Foot of Orion	5	01	8	34	S
The Goat-Star Capella.	4	55	45	40	N
The Bright Side of Perſeus.	3	04	48	48	N
The Head of Meduſa.	2	49	39	48	N
The Northern Scale of the Ballance.	15	01	8	17	S
The Bright Star in the Northern Crown.	15	23	27	43	N
The Bright Star in the Serpent's Neck.	15	33	16	21	N
The Head of the Scorpion.	16	12	25	46	S
The Head of Hercules.	17	02	14	45	N
The Head of Serpentarius	17	22	12	48	N
The Right Shoulder of Serpentarius.	17	29	4	43	N
The Bright Star in the Harp.	18	27	48	33	N
The Bright Star in the Eagle.	19	37	8	08	N
The Hand of Antinous.	19	56	1	39	S
The Right Shoulder of Aquarius	21	51	1	43	S
The Shoulder of the Flying-Horſe.	22	50	13	38	N
The Production of the Legs of the Flying-Horſe Scheat.	22	50	26	30	N
Mouth of the Southern Fiſh Fomalhaut.	22	41	31	51	S
The Head of Andromeda.	23	53	27	28	N
The Firſt Star in Orion's-Belt.	5	18	0	39	S

BR. MUS.

FINIS.